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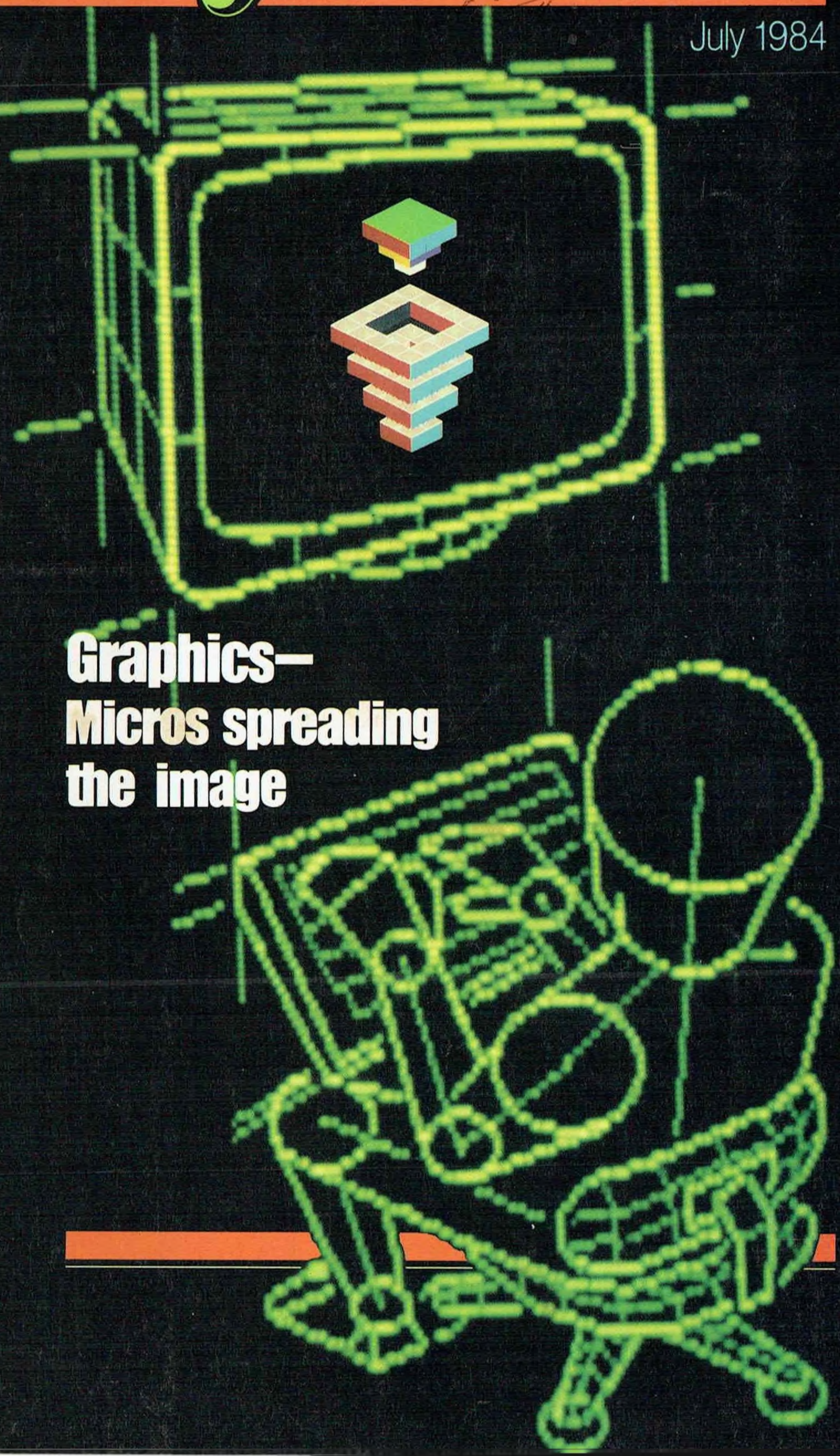

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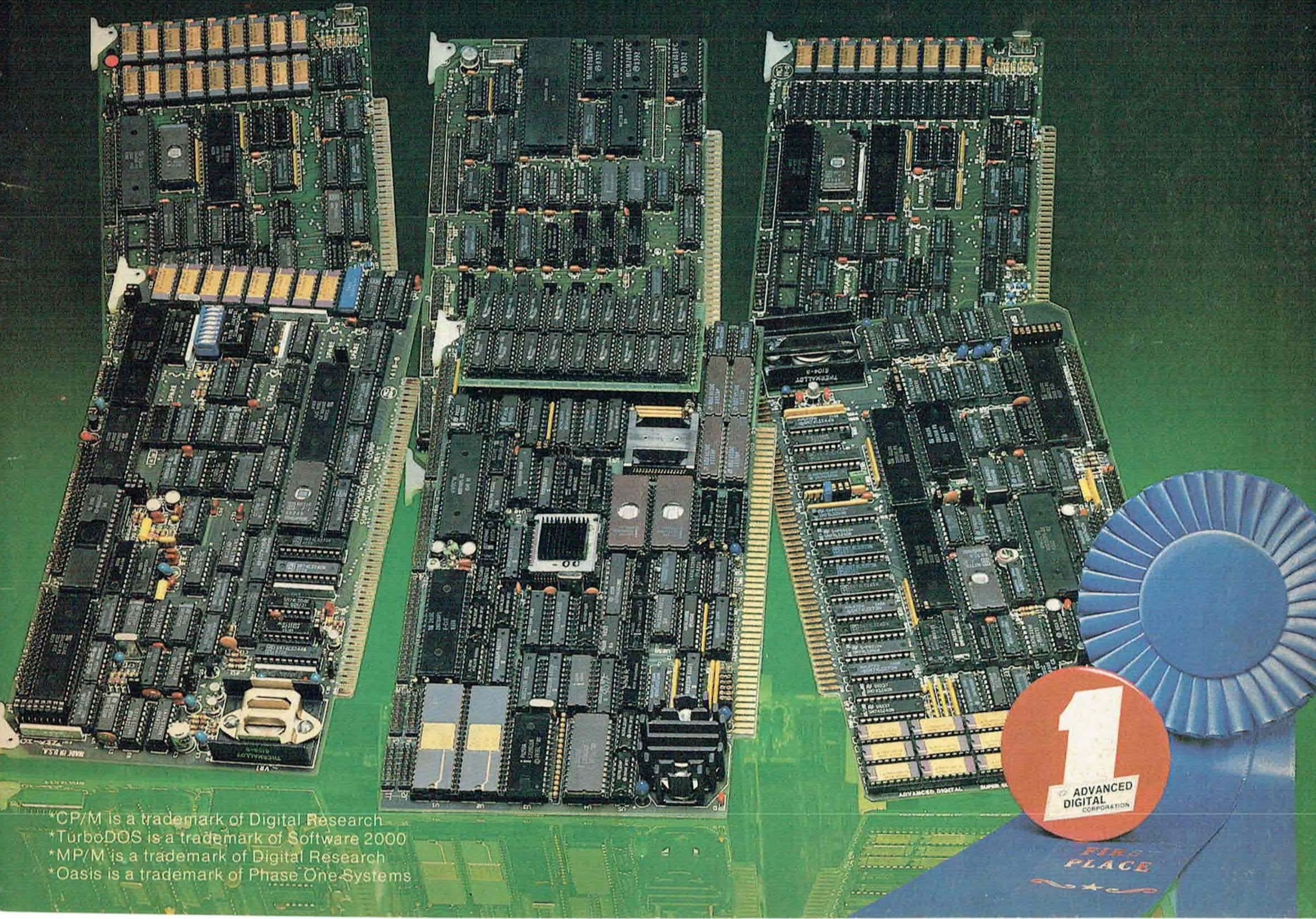

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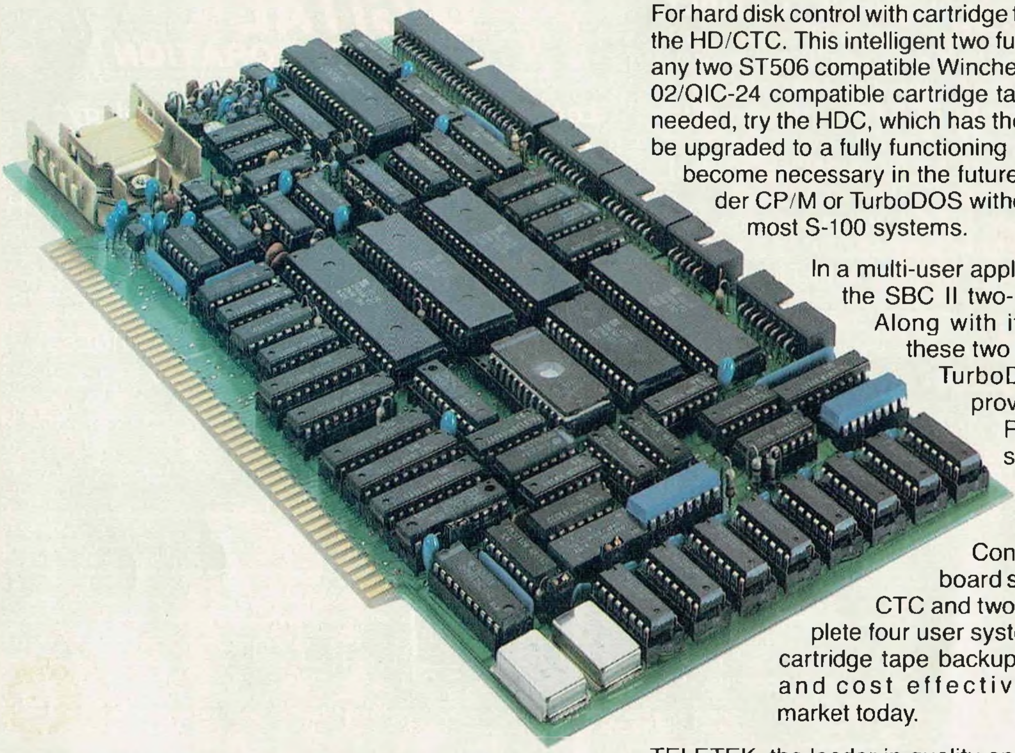

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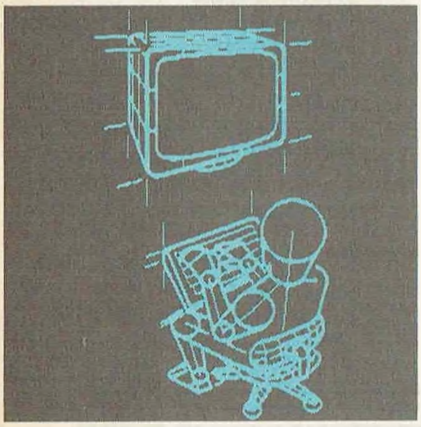

Graphics—

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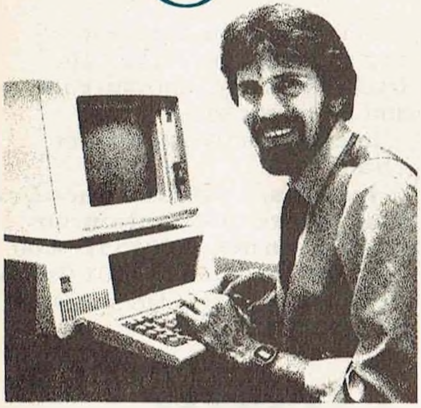

Microcomputer graphics: the need for standards

by Mark Rollins

One of the more exciting developments occurring in the microcomputer industry is the explosive growth in the use of computer graphics. Where this was once almost entirely the domain of mainframes and superminis, now micros have entered the fray—spreading the image. This has been made possible by the increased address space and computing power of 16-bit micros, and by more powerful graphics cards and add-on graphics device peripherals for 8-bit micros.

Graphics is proving to be a very powerful, and efficient, way to communicate information. Studies have shown, for instance, that managers making a proposal to superiors stand somewhat more than a 20% better chance of winning approval when they include graphics in their presentation. And vendors making a presentation to prospective clients experience something more than a 15% increase in the rate of response when they include graphics.

On the other hand, creating these graphics is quite an expensive proposition. This is particularly true for the systems developer working in a varied hardware environment. It is expensive enough for the end user, who has an applications package for creating business graphics or a drawing package for creating free-form images. The user will probably need to create the graphics, and possibly to alter or modify them, but only for the hardware environment he has chosen to purchase. The time alone to create these images is expensive enough, but at least once created, they are liable to remain relatively stable, and the user is not likely to incur any significant *additional* expense.

For the systems developer, on the other hand, the expense is often multiplied. This is due to a general lack of standards for a graphics interface, and is particularly true if the systems developer wants to move an extensive project from one hardware environment to another. Whether the project features a sophisticated database of images or there are extensive graphics drawing primitives integrated into the code, it becomes prohibitive to have to rework all the images and the code in order to migrate to different hardware.

In the micro world, there is no *DI-3000* (from Precision Visuals), no *Telegraph* (from ISSCO), nor any Megatek product, as there is on the larger machines. What we do have is *HALO* (from Media Cybernetics), GSX (from Digital Research), a few NAPLPS interpreters, a couple of relatively crude CAD/CAM products, a handful of graphics subroutine packages, and some business graphics interfaces integrated into a few spreadsheet and other applications packages. Valuable as each is in its own way, they have not been integrated into enough applications and graphics tool packages to be useful in a multiple hardware environment. The work that has thus far been done is but a first step toward the development of a truly valuable standards environment for the systems developer.

One problem, of course, with any standard is that it cannot conveniently accomodate special hardware features from different individual hardware devices. It's sort of a least-common-denominator type of situation. Graphics is, by nature, tied closely to the hardware it is output on. Any standard would preclude taking advantage of special hardware features of one device not shared in common by all devices, or of a device from one vendor not shared by the same device from other vendors. It would at least preclude such a feature without a great deal of software overhead to allow devices not having a particular feature to emulate that feature in software. An example of this for terminals is the clear-to-end-of-line and clear-to-end-of-screen functions; for graphics an example is sprites.

This overhead can be accomodated by utilizing increased power that we are getting from more powerful microprocessors. It is a small price to pay for the incredible value and flexibility to be derived from having graphics standards. Rather than expending most of the micro industry's development energies on creating multiuser systems, some of that energy should be put into developing graphics capabilities. Graphics is an area that could potentially require more cooperation between the hardware and software communities than any other thus far in the industry. The reason for this can be summerized briefly as follows: it doesn't pay to develop graphics standards if there isn't enough hardware processing power for those standards, and if display technology doesn't provide inexpensive enough high resolution. But it doesn't pay for hardware to provide the processing power and inexpensive display technology if graphics can't use it anyway because of not having the standards. Cooperation is needed to develop the graphics capabilities being asked for by the user community.

In this issue, we take a look at some of the problems that plague the micro graphics arena. For instance, the expense of graphics is affected not only by

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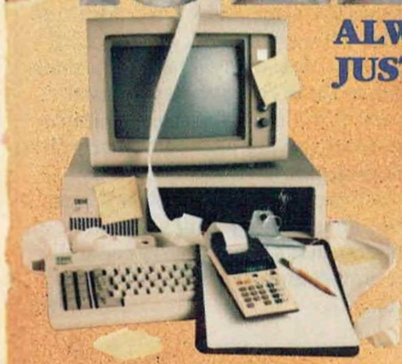

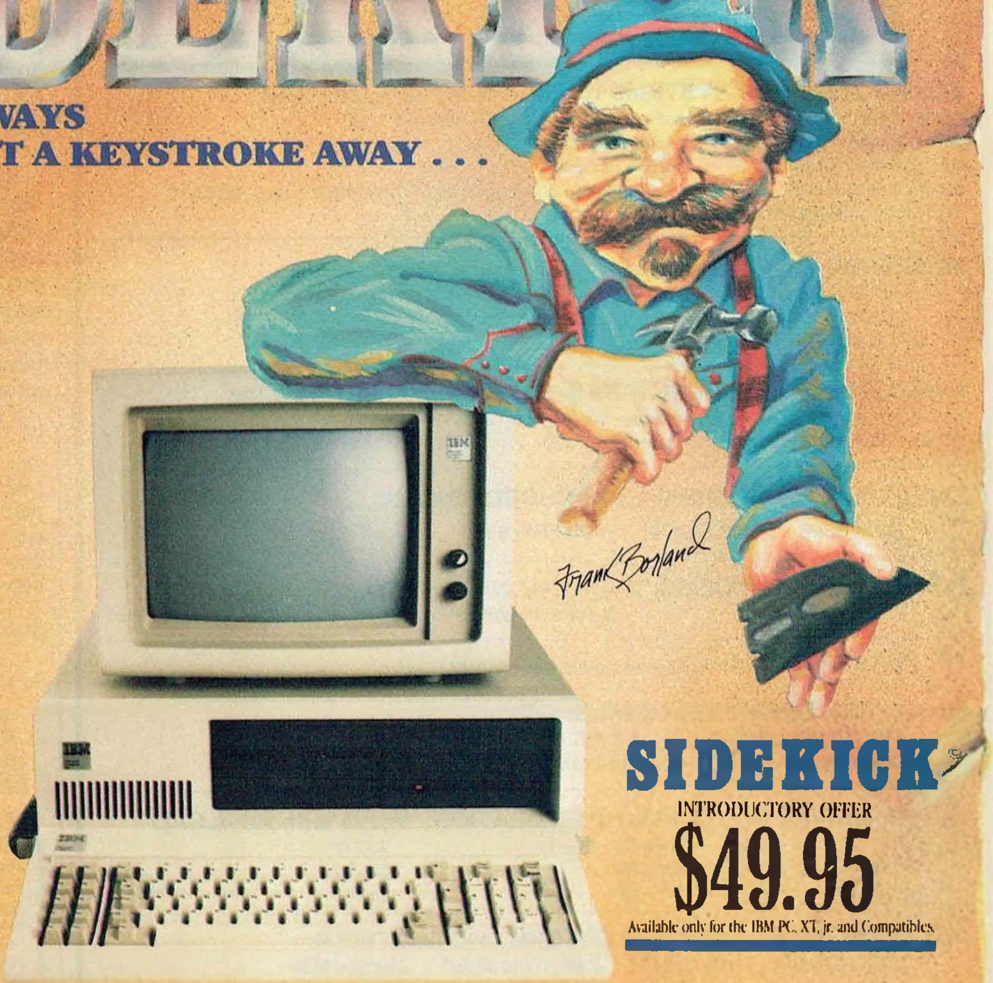

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EDITOR'S PAGE

Continued from page 6

the lack of standards, but also by the cost of the display device. Graphics monitors which yield high resolution currently cost more than most complete micro systems. Alan Matthews investigates computer graphics technologies, with an emphasis on display devices. Some of the problems relating to standards are investigated by Dave McCune and Bill Wong, who look at NAPLPS and GSX, respectively. David Fournier compares three computer systems at different price levels for their graphics capabilities, paying particular attention to the programming and standards interface capabilities. And Ron Lusen reviews an add-on graphics device peripheral that adds graphics capabilities to any computer with an RS-232 interface.

Credits

page 66:	*Drawing by Jim Ceribello*
page 43:	*Highway No. 1: Lucasfilm Ltd.*
page 45:	*Flowers: Raster Technologies*
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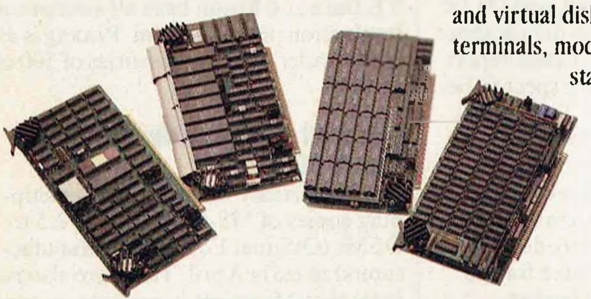

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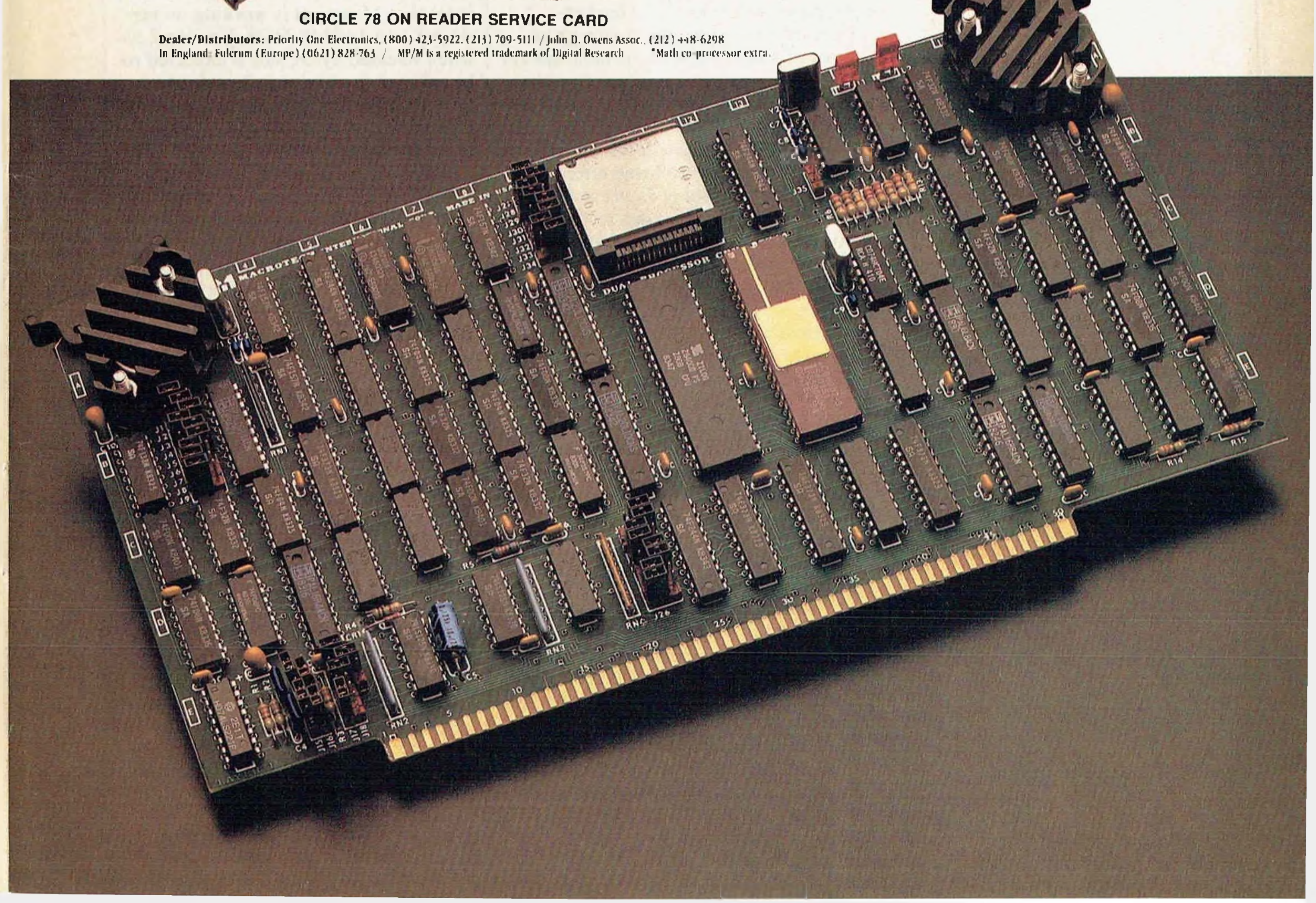

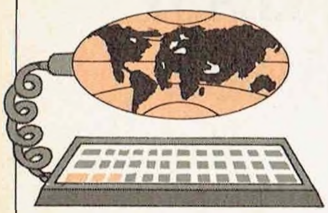

News & Views

Random rumors and gossip, plus a view of the industry's latest trends

by Sol Libes

Digital Research has changed the name of its new version of Concurrent CP/M to "Concurrent PC-DOS," which will no doubt create a great deal of confusion in the marketplace. They have disclosed that they are working on versions to run on the new 32-bit micros from Intel and Motorola. The current version of Concurrent PC-DOS will run all CP/M-86 software and PC/MS-DOS version 1 software. It will not run PC/MS-DOS version 2 software. DRI is known to be working on version 2 compatibility. . . . Gary Gysin, DRI product line manager for operating systems, has disclosed that DRI is working on a brand new OS for introduction next year. No details about it have been released. . . . Latest report is that Microsoft does not expect to begin shipping the Window Toolkit, its windows extension for MS-DOS, until late August at the earliest. Microsoft had originally planned to release the product in April and to begin shipments in late May, so that software developers could begin creating software for the Windows extension. . . . Hewlett-Packard has reportedly shown prototypes of a new 9-pound portable system that has Lotus 1-2-3 and word processing in ROM. The unit will have a 16-line by 80-character flat-screen display and 256K of RAM, and will sell for $4K. Similar units are also being offered by Hitachi and Mitsui of Japan as OEM products. Expect the units to go on sale this fall. . . . Tandon Corporation is rumored getting set to release a new 5.25" floppy disk drive that could store 6 MB and be expandable to 12 MB. . . . IBM is rumored working with Matsushita of Japan on the development of a notebook-size computer using a CMOS version of the 8088 and a 3" disk drive. . . . IBM is also rumored to be doing product evaluation testing of a less-than-8" laser disk drive. The read-only drive should be able to store between 0.5 and 1 gigabyte. 3M is rumored to be the media supplier.

New PC disk drive

There are increasing rumors that IBM will soon introduce a new 5.25" floppy disk drive option for the PC and XT, as well as for the Displaywriter and Datamaster systems, that can store up to 1.6 MB. This new size is expected to become a standard for 5.25" floppy disks, since more than six drive manufacturers are known to be planning the introduction half-height versions of these units shortly. At present, 28 floppy disks are needed to back up the hard disk drive of an IBM-XT. This new drive will reduce that number to six.

These units are expected to use dual-speed motors and to read either 48 tpi or 96 tpi diskettes. The drive motors can run at either 300 or 360 rpm. At the higher rate, the drives would be compatible with 8" drive controllers that use the IBM disk format as a standard. (Currently there is no standard format for 5.25" drives.) Thus these new drives could serve as easy replacements or add-ons for the 8" drives used in the Displaywriter and Datamaster. This would greatly enhance the portability of disk files between different IBM systems, which is currently a problem

Teac and Mitsubishi Electric are already producing these units, and Shugart, Qume, Matsushita, Tandon, YE Data and Epson have all announced production plans for them. Pricing is already under $200 in quantities of 500 or more.

Microsoft reported shipping MS-DOS V2.5 to OEMs

Reportedly Microsoft began shipping copies of MS-DOS version 2.5 to OEMs (Original Equipment Manufacturers) in early April. There are also rumors that Microsoft is working on versions 3 and 4 of MS-DOS. Version 2.5, when released by OEMs, is expected to be referred to as version 3, and is believed to support multitasking and some networking, plus some other new features. It is expected that version 4 will contain a high compatibility with the Microsoft XENIX multiuser operating system. Version 4 is not expected to be released for sale until next year.

Microsoft is also known to be working on MS-Net, a networking extension of MS-DOS. This product is also not expected to be released until next year.

Osborne reorganizes

Osborne Computer's Chapter 11 reorganization plan has been accepted by the Federal Bankruptcy Court and now goes to creditors for approval. Creditors will get $15.5 million of the more than $41 million owed and stock options in the new company. Ronald J. Brown will take over as President, with Adam Osborne (founder) and Robert Jaunich (previous president) as members of the company's board. The company will seek up to $3.3 million in research and development partnership funding. The reorganization plan's strategy calls for OC to focus on penetrating niche markets and on strengthening international operations.

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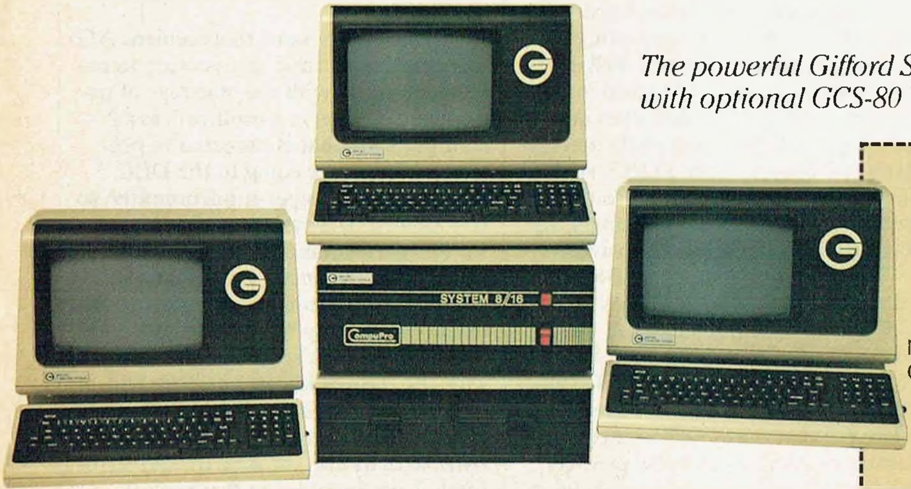

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NEWS & VIEWS

Continued from page 10

At a recent computer show, OC was hawking its year-old Model II and showing a prototype of an IBM PC-compatible portable which they are promising to get into production by the end of the summer. At the time they filed for reorganization, OC had 6,000 model I units still in stock. They report that virtually all of these are gone, having been sold primarily in Europe, where OC systems are still very popular.

Meanwhile, Adam Osborne, who is still on the board of directors of OC, has formed a software company called "Software Seed Capital Corp." to distribute "popularly priced software packages" via bookstore chains.

UNIX news

Motorola has announced that their implementation of UNIX System V for the 68000 has passed all AT&T tests and is the first such implementation to be certified by AT&T. They expect to have an enhanced version for their 68020-based system when that chip becomes available.

Yates Ventures, *4962 El Camino Real, Los Altos CA 94022*, a UNIX market research firm, publishes an excellent (but expensive. . .$450/yr) monthly newsletter for UNIX users entitled *The Yates Perspective.* Their March issue carried two excellent articles on the IMB PC/IX UNIX implementation for the IBM XT. They conducted benchmarks on five different implementations of UNIX on the IBM-XT (IBM's PC/IX, Venix, Microsoft/XENIX, QNIX and SriTek/XENIX). I refer the reader to these specific articles, but generally speaking, the SriTek/XENIX was the fastest and Microsoft/XENIX the slowest.

The SriTek/XENIX is an implementation of Microsoft's XENIX running on a 68000 coprocessor card. Microsoft has been demonstrating XENIX for the IBM XT for well over a year, but as yet has not released it for sale. Apparently Microsoft does not want to get involved in directly marketing an operating system. PC/IX is a single-user system, while all the rest are multiuser systems. Not suprisingly, the IBM system is the most expensive.

Yates also predicts that IBM will add the Berkeley enhancements to PC/IX and, if UNIX version V becomes popular, will bring out a System V for the XT. They further predict that IBM will use XENIX as the operating system for their new 80286-based multiuser system. Yates also predicts that "UNIX will emerge as the only operating system offered by IBM as a prelude to an AT&T buy-out of Big Blue." Considering that AT&T grosses about $34 billion annually and IBM $32 billion, I think the last prediction is unlikely.

Microsoft has disclosed that it will soon make a XENIX version that is compatible with UNIX System V and will add the Windows environment to its XENIX operating system. It is expected to emulate the Apple Macintosh user interface and have overlapping "pull-down" windows. AT&T and Convergent Technologies Inc. have also announced that they will introduce window-management front ends for UNIX.

32-bit micro news

Intel was the first company to introduce a 32-bit microprocessor chip set almost four years ago. Called the iAPX432, Intel imbued it with a very powerful architecture in full expectation that it would rival the DEC VAX 11/780. Unfortunately, the performance of the device proved disappointing, and only one small company, in England, ever introduced a computer using this chip set. Intel continued working on it and several months ago introduced an improved set, which, nevertheless, met with a ho-hum reception, since other 32-bit chips are now finally reaching production. At this point, Intel is effectively no longer marketing the iAPX432.

> **Microsoft is planning a network for MS-DOS.**

Now comes word that Siemens AG has joined with Intel in a venture to enhance the 432, with the objective of using these devices in a multiprocessor configuration that is expected to provide performance equal to the DEC VAX 11/780, a super-minicomputer, to be followed by a system in the VAX 11/750 performance class (the 750 is DEC's new enhanced version of the 780). The goal is to introduce this device in late '86 or early '87. The project is expected to provide some compatibility with the 8088/8086 architecture and, eventually, a version of the 432 for use in desktop machines. It is suprising that IBM, with its current 20% ownership of Intel, is not involved in this project.

NEC has disclosed that it will enter

the 32-bit microprocessor market with a family of CMOS devices to be introduced in late 1986. . . now how's that for advance notice! NEC claims that they already have an agreement with AT&T to support UNIX on this chip set. As a sidelight, NEC will soon start sampling proprietary 8-bit and 16-bit microprocessors. The 16-bitter will be object-code compatible with the Intel 8088/8086 and contain 101 instructions, 84 of which are 8088/8086 instructions.

User group news

PicNet, *Box 391566, Mountain View, CA. 94039* is a very active CP/M User group. It publishes a newsletter (typically 40 pages) and is a source for public domain software. Membership is $24/yr U.S., $36/yr elsewhere.

The **Epson QX-10 Users Group,** *Box 1076, Lemont, PA 16951* is producing a newsletter, doing group purchasing, and distributing public domain software. Dues are $20/yr.

BUG (Baltimore Users Group), *Box 223, Owings Mills, MD 21117* is oriented to supporting the IBM PC and compatible computers. They hold meetings and publish a newsletter.

The **Yavapai County CP/M Users Group** meets monthly in Prescott, AZ and maintains a public domain software library. Write: Julie Woodman, *Box 68, Kirkland, AZ 86332.*

The **PC Users Group of Colorado** meets monthly in Boulder, CO and publishes a newsletter. Membership is $12/yr. Write: **PC Users Group of Colorado,** *Box 944, Boulder CO 80306* or call *(303) 443-5528* (evenings).

The **CP/Morrow Computer Group** meets monthly in Sacramento, CA and publishes a newsletter. Dues are $12/yr. Write: **CP/Morrow Computer Group,** *Box 654, Carmichael, CA 95608.*

Random news

Sharp is currently selling, in Japan, an under-$1,000 CP/M-80 system called the X-1, with color video output gen-locked to standard NTSC color video. This will allow users to superimpose computer graphics on top of a color TV, videotape or disk image. . . . Digital Research announced that it has acquired Owlcat International Corp., a Chicago-based educational software company. OIC is a year old, has about 15 employees, and develops programs to help students prepare for the SATs. . . . Bill Gates, President of Microsoft, developer of PC/MS-DOS, stated that by the end of 1983 this operating system was running on over 1 million personal computer systems. DRI claims that CP/M is currently running on over 2 million systems. ◼

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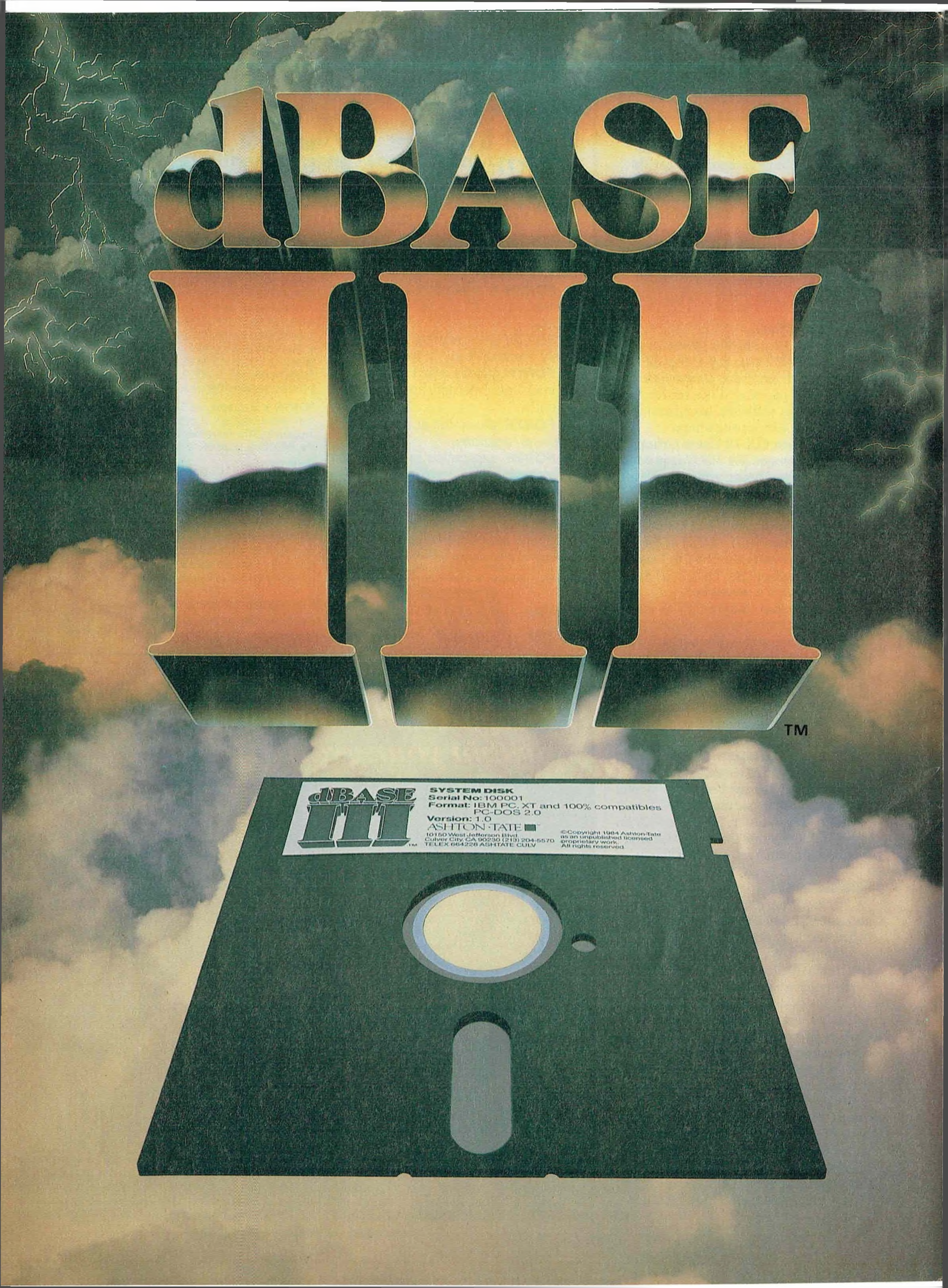
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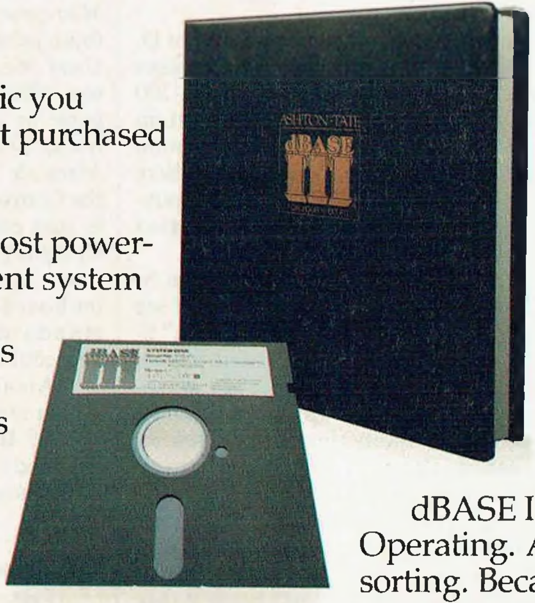

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The S-100 Bus

Building your own S-100 computer; speeding up front panel circuits; Mitsubishi half-height 8″ drives

by Dave Hardy

Before starting on next month's heavy dose of IEEE-696 theory (slave processors), I thought I'd finish up that last stack of reader mail. This month's questions involve building an S-100 computer, problems with front panel circuits and high-speed operation, and using a Mitsubishi half-height 8″ drive.

Do it yourself

The first letter comes from John D. Tischer of Columbus, OH, who says that he wants to build his own S-100 Z80-based computer "from the bottom up" and would like some information on how to get started, including where to get schematics, documentation, published articles, books, etc., and also where to get a "bare" motherboard.

Most of the boards in my own S-100 system are wire-wrapped, and I see no problems with "rolling your own" S-100, except for the motherboard, which, of course, can't be reliably wire-wrapped because of its design. Using a commercial motherboard is, as you indicated, the best idea. Concerning which one you should use: there are several good ones available. I have had good luck with the CompuPro 155 series and the Morrow "WonderBus" motherboards, but I don't know if they are available in bare-board versions. The Vector 8803 series is available as a bare board, however, and in 6- and 18-slot configurations, including active termination circuitry (which is a "must," especially for home brewing). There are several other brands available, and you might check with some of your local parts and computer stores for more information about this.

Unless you plan on actually etching and drilling the S-100 boards, you'll probably want to wire-wrap (or point-to-point wire) on an already made S-100 prototyping board. Again, there are several manufacturers of blank and "do it yourself" S-100 boards, but in case you can't find any locally, these can be mail-ordered from several sources, including many of the advertisers here in *Microsystems*. (Vector makes several models that work quite nicely.)

Now, down to the basics. Before you can start building, you'll need some information on the S-100 bus, and maybe some sample circuits. One of the nice features of the S-100 bus is that it is *very* well documented. You can write to the IEEE directly, if you want, and purchase a copy of the IEEE-696 (S-100) bus specifications, or purchase a copy of any of several books about S-100 design. The best reference, by far, for learning about the S-100 bus, and how to design and build circuits for it, is *Interfacing to S-100/IEEE-696 Microcomputers* by Sol Libes and Mark Garetz (Osborne/McGraw-Hill, 1981). If you are already familiar with TTL and general electronics, then reading this book will make you an S-100 wizard. It even includes a preliminary version of the IEEE-696 standard (although you will still need the final version published by the IEEE). Other books you may find useful are the *Zilog Data Book*, the *Zilog Microprocessor Applications Handbook* (both published by Zilog, Inc.), the *Z80 Users Manual* by Joseph J. Carr (Reston, 1980), *Build Your Own Z80 Computer* by Steve Ciarcia (Byte Publications, 1981), and the *CompuPro User Manuals, Volumes I* and *II*. Although the CompuPro User Manuals are mostly just collections of manuals for the CompuPro product line, they also contain a great deal of useful information on board interfacing, the IEEE-696 standard, and system integration procedures.

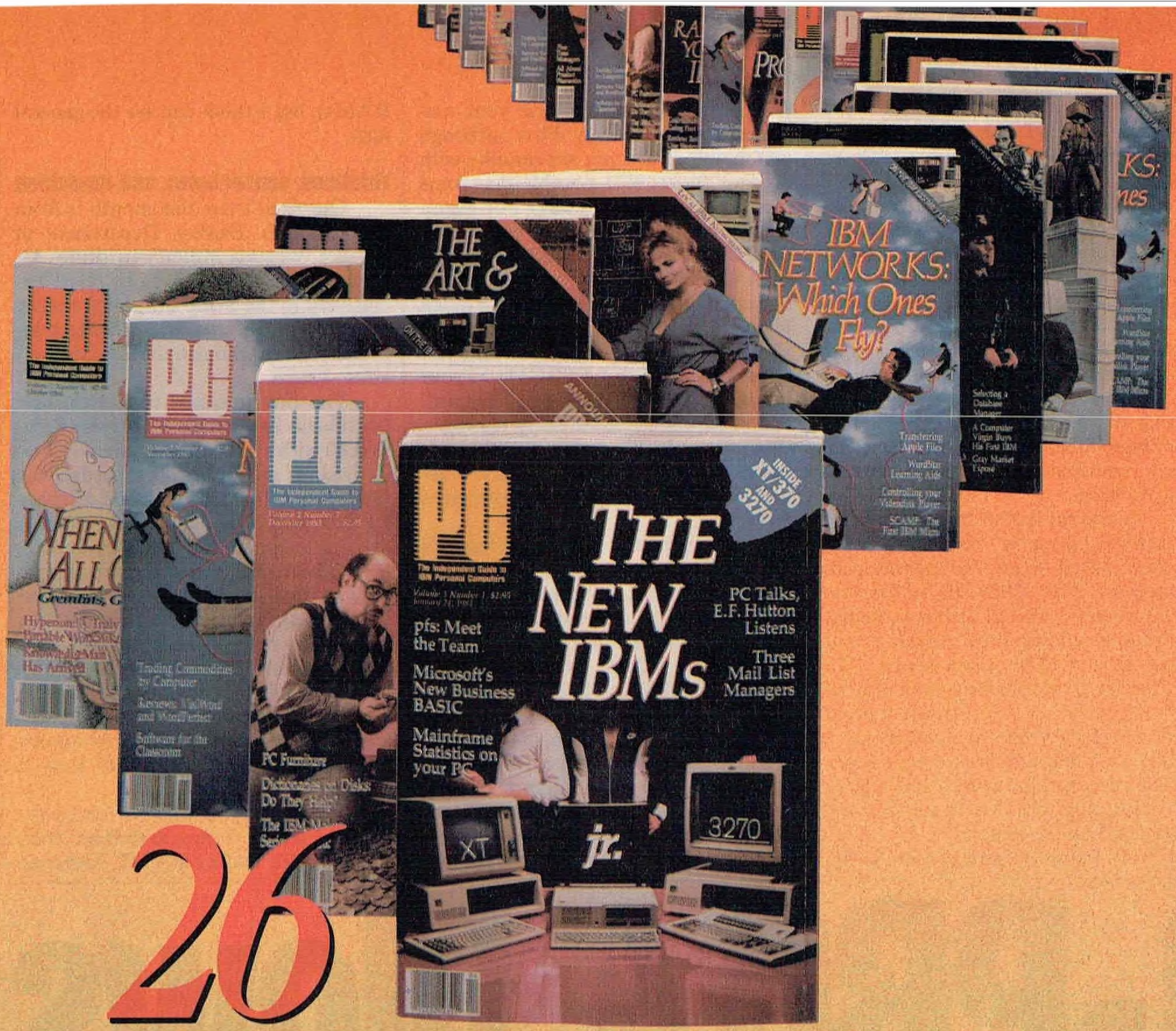
Another excellent source of S-100 design ideas and schematics is back issues of *Microsystems*. Past issues have included tutorials on the IEEE-696 bus, Z80 design, and several useful S-100 boards.

Front panel and memory puzzle

Letter number two is from John Gill of Blountville, TN. John has an IMSAI mainframe populated mostly with CompuPro boards, including a Z80 CPU that runs at 6 MHz. Unfortunately, he had to replace the IMSAI front panel when he speeded the machine up to 6 MHz, because it caused the machine to operate erratically. He asks: "Do you think that it is possible or feasible to make changes in the front panel so that it will operate at 6 MHz?"

Although I run my own S-100 machine at 6 MHz with an IMSAI front panel, I can't really say that the IMSAI front panel will work reliably at any speed over 4 MHz. There are a number of changes you could make to the front panel PC board that would eliminate most of the problems involved (see previous "S-100 Bus" columns), but there are some elements of the front panel circuit that are "taxing" to high-speed operation.

The most obvious problem would be the address and status LED indicators that are driven *directly* by the bus. A more reliable way would be to install some open-collector driver ICs to transport the signals from the bus lines to the LEDs. In addition, many of the old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The S-100 BUS

Continued from page 16

IMSAI front panels have several "field modifications" for such things as old dynamic RAM boards and memory protect which could cause you a lot of grief if they weren't noted on the front panel schematics (and they are *not* noted on mine). My recommendation would be to wire-wrap a new front panel PCB (or heavily modify your old one) to allow just monitoring the signals and resetting the machine. You could retain the Single-Step, RESET, and External Clear functions, too, without causing any problems.

The second half of Mr. Gill's letter concerns a "mystery" that many readers have asked about. He says that although the 2516 EPROMs in his machine are only rated at 350 nsec, he has no trouble running them, without wait states, at a 6 MHz clock speed. "To me," he says, "this means a cycle time of 167 nanoseconds—less than half of what the EPROMS are rated for. I would think that they would be so erratic that the machine would fail after a very short time, if it ever came up at all. I just don't understand it."

Well, there are several things that may be happening to cause your machine to work this way. First, although you mention that you are running with no wait states, is it possible that some are being inserted anyway? For example, you may have the ability to generate wait states on the CPU card *and* on other RAM/ROM cards. Second, I have seen many memory ICs operate at much higher speeds than their ratings would allow, so it is possible that you may just have some very fast EPROMs in your machine (although unlikely). The third, and probably the most likely reason, is that although the system cycle time is 167 nsec, the memory access time is actually much greater—maybe as high as 400 nsec.

The additional buffers and control circuits in the machine's memory circuits (inside and outside of the CPU) must be taken into consideration when determining memory speed, and delays introduced by these devices can often add up to a few hundred nanoseconds. If you add a 200 nsec time delay to the 167 nsec cycle time, then suddenly the 350 nsec access time of the EPROM becomes acceptable to the circuit. This is a gross oversimplification, and there are many other factors to be considered (especially when dealing with dynamic RAMs), but I think you see the general idea.

Thinlines, sensor holes, and repacking

Our final letter this month is from Dr. David L. DuPuy, Department of Physics, Virginia Military Institute. Although none of his questions relate exclusively to the S-100 bus, all three are probably known to most S-100 users, especially those who run the CP/M operating system.

The first question concerns using Mitsubishi half-height 8" drives (Revision E) with a CompuPro system (CPU-Z, Disk 1, and RAM 16 boards). Dr. DuPuy says that although one distributor has told him that the Revision E drive is "incompatible" with his system, he has been able to use the drives with only an occasional glitch on warm boot. In addition, he mentions that the only basic difference between the Revision "E" drive and the earlier models is an improved collet (or clutch), and he wonders if anyone else has found any problems or solutions with the combination of CompuPro plus Mitsubishi Rev. E thinlines.

Should any readers wish to respond, I will be happy to forward their replies to Dr. DuPuy at VMI. Although

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I use the Rev. E drive myself, I have not used it with a Disk 1 controller board. I have spoken to Mitsubishi about this and they can offer no solution, since they are not familiar with the Disk 1 controller. But maybe this will help: The problems with the collet concern only disk insertion. Because the drive motor is not yet spinning when a disk is inserted, it is very easy for the disk to not be seated properly in the collet. If a disk is not inserted properly, the trouble will usually be immediately obvious, either by the loud "crunching" sound made by the disk as it rotates (or, at least, tries to), or by a BDOS error when CP/M realizes that it can't read the disk (or else the system may just "lock up"). But in either case, the problem will most likely occur on the very next disk access, not just occasionally on a warm boot, as you mention. A more likely cause of the problem might be that the BIOS doesn't allow time for the disk drive motors to get up to speed (assuming that you are running the drives with the motors switched on by the drive select or head load signals). You should be able to determine if this is the problem by restrapping the drive so that the motor is always running. If the problem goes away, then a small BIOS modification to add a time delay during warm boot should solve the problem. Unfortunately, I can only offer these guesses, since I have not been able to duplicate the problem myself.

Dr. DuPuy's second question asks: "...are there any rumored or substantial reasons not to 'move' the sensor hole in order to use single-sided disks on a double-sided drive? I realize the disk may not be certified error-free on the back side, but I have software to check that. I have tried this, and it seems to work well."

Actually, there are none! My spies at Dysan tell me that the only difference between a single-sided "cookie" (that's the oxide-coated mylar disk inside the vinyl diskette jacket) and a double-sided one is that the double-sided one is tested (and verified) on both sides. Although you take your chances using the second ungraded side, there are many programs, including the public domain FINDBAD program for CP/M, that can "grade" the disk for you and mark out the bad sectors, as long as they are not in the directory or system area of the disk.

Which brings us to question number three: Dr. DuPuy asks if there is any "squeeze" software available, similar to the SQUEEZE command used on DEC RT11 systems, that can be used to repack the files on a disk. This might be more appropriate for "The CP/M Bus," but as an RCPM sysop, I can never pass up a good question. Unfortunately, I don't have an answer for this one. There is a public domain program for compressing INDIVIDUAL files, and also one for sorting and packing the CP/M directory, but, short of PIPing everything off the disk, erasing it, then PIPing it all back on, I don't know of any way to repack the contents of a disk. Oh well.

Next month

As I warned earlier, the August "S-100 Bus" will be dedicated to S-100 slave processors and how they work in an IEEE-696 environment. Master-slave and multiple-slave S-100 configurations are becoming more popular as manufacturers begin to realize the incredible power that these inexpensive multiple-processor arrangements have to offer. Next time, we'll see why.

This column is intended as a forum on S-100 bus topics. Readers are encouraged to send in questions on the S-100 bus, which I will attempt to answer. Please write to: Dave Hardy, 736 Notre Dame, Grosse Pointe, MI 48203.

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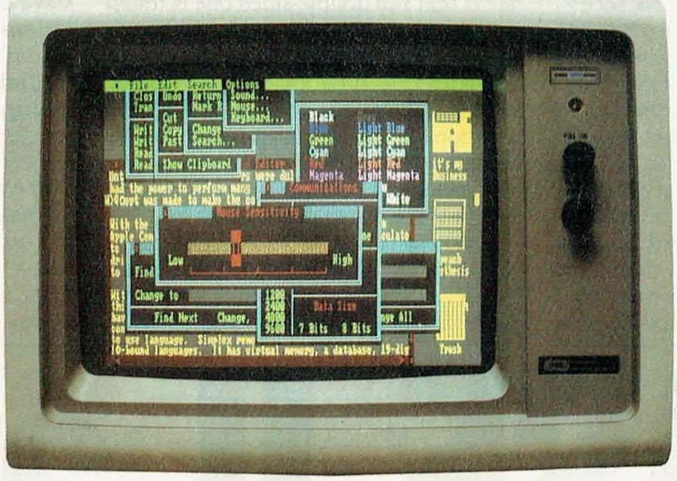

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CIRCLE 21 ON READER SERVICE CARD

The MS-DOS Window

Concurrent DOS 3.0 from DRI; Master Media; and "freeware"

by Hank Kee

We have all by now heard of CP/M and PC-DOS. To compete more effectively with PC-DOS, Digital Research released Concurrent CP/M, which permits concurrent operation of up to four tasks. This was shortly followed by windows to view these concurrent tasks. Microsoft also has adopted windows for MS-DOS.

The concept of Concurrent CP/M from Digital Research was very nice except for one major factor: most if not all of the significant software of late has been written for some version of MS-DOS. More specifically, it has been written for PC-DOS operation.

Lotus 1-2-3, for example, is currently the top-selling personal computing software package. This is available only for systems running under MS-DOS or the equivalent. Lotus now has a variety of MS-DOS implementations for various top-selling PC systems. It would be nice to have Lotus available as a concurrent task with, perhaps, other CP/M products.

Digital Research has now released Concurrent DOS 3.0, which permits CP/M programs to access PC-DOS file formats and PC-DOS programs to access CP/M files. Up to four CP/M and PC-DOS tasks may run concurrently with another. The native operating mode is still CP/M; PC-DOS 1.10 runs under an emulator. Concurrent DOS runs very smoothly; it's like having the best of both worlds. I did not experience any processing difficulty when intermixing PC-DOS 1.10 programs with CP/M-86 programs.

However, there are operational differences. A DIR listing of the PC-DOS media appears across the screen just as it would under CP/M. There are no indications of date and time stamp, nor of file size. Although user numbers can be used, these are much more effective with the hierarchical structure of PC-DOS 2.1. Well, DRI hasn't yet stopped being creative—during the last quarter of this year, they will release Concurrent DOS 4.0. This release is slated to incorporate PC-DOS 2.1 as its native operating system, and all the previously mentioned desirable attributes of PC-DOS 2.1 will be included.

Concurrent DOS, even in its current form (3.0) in which hierarchical catalog structure is not available, is a very attractive offering. But when version 4.0 is released, this will surely be known as *the* operating system of the dynamic duo. The only drawback is that it is memory hungry. Contrary to popular opinion as offered by Big Blue, memory is not necessarily "cheap"—at least not for hobbyists. And even if we accept the premise that it is cheap, we are still limited by the maximum of 640K.

Concurrent DOS 3.0 will sell for $150—a very reasonable price, considering the cost of $40 for PC-DOS. The price for Concurrent DOS 4.0 has not been made known yet.

Master Media postscript

As a followup to last month's reference to Master Media, MDG and Associates have recently released yet another enhancement to this system. The original Media Master version 2.01 runs on Digital Equipment's Rainbow PC. Media Master provided the user with the ability to read as well as write information for transport to well over 20 different formats. The only condition for the transport of files from the Rainbow's 96 tpi diskette drive onto, let's say, an IBM 48 tpi diskette drive, was that the new floppy must first be formatted on the IBM PC system. MDG and Associates have since released an enhancement to the original system that allows the user to format a disk for another system on the Rainbow itself.

I found that it was possible to convert from one alien format to another without creating an intermediate Rainbow-formatted file. In addition, a few more formats have been added. For more information, contact: **MDG and Associates**, *4573 Heatherglen Ct., Moorpark, CA., 93021; 805-529-5073.*

What-ware?

Since the early fifties, the computer term "hardware" has referred to the metal and plastic of the equipment and its associated peripherals. As the need developed for support systems to assist the user to communicate or process with the computing equipment, the term "software" was coined to mean both the "soft"(i.e., paper) portions of the system—specifically the documentation and the program listings, or the intangible programs themselves resident on magnetic tape or in memory.

Then, in the mid-sixties, microcode was incorporated into the hardware. At first, it resided on floppy disks, to be read as needed; today, however, this form of code resides on a ROM chip. It has been dubbed "firmware" and is copyrightable. In a series of recent decisions, the courts have upheld the legality of such a form of copyrighted proprietary coding.

Now a strange new term has surfaced within the industry. The word

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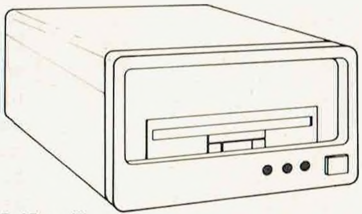

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CIRCLE 98 ON READER SERVICE CARD

MS-DOS Window

Continued from page 21

"freeware" has spawned from the community of IBM personal computer public domain software. The term "freeware," liberally defined, means software made available to the public, while at the same time the author reserves and retains the right of selective distribution. Some authors have further limited the distribution to certain classes of users. At the present time there has not been a court case to test the legality of this procedure. Nor will you at present find the word "freeware" in your dictionary.

Public domain programs in the various CP/M libraries have traditionally been donated with no strings attached. They are often accompanied by source code with a reasonable degree of documentation. The caveat is that the software is available without support. That in itself seems to be fair.

In the IBM public domain sector, however, authors are openly soliciting "nominal donations" ranging from $5 to $75. Some of these authors will support their programs; others won't. The documentation has in most cases been superb. Most authors do not make source code available. You are invited to freely copy the object code versions of their programs for friends and relatives, but they do reserve the right to determine who may receive distribution. If source code is provided, some authors have prohibited modifications without written approval. Essentially these freeware programs come with strings attached. They are in public domain as freeware as a means of introducing or marketing a product without the expense of using normal commercial channels.

It appears that most CP/M hackers are pure hobbyists at heart, whereas there is an active element within the IBM personal computing community that is a little more commercially oriented or perhaps have a greater enthusiasm for commercial enterprise.

Freeware

A significant contribution in freeware has been PC-File III, written by Jim Button. This is a very easy-to-use data query system that references a single file at a time. I don't believe in reading computer reference manuals unless it is absolutely necessary—after all, personal computing is supposed to be user-friendly. In the case of PC-File III, I didn't need to pore through reams of documentation to get started. PC-File III has been very well supported by Jim Button. Although source code is not available, PC-File III has been under constant update, with new functions as well as maintenance fixes being released very frequently.

As if he had nothing else to do, Jim Button has also made a significant contribution in a program called PC-Dial (originally called 1 Ringy Dingy, or 1RD). For those who want more information, including accessing of the software, please contact: **Jim Button**, *P. O. Box 5786, Bellevue, WA 98006.*

Another notable contribution to the concept of freeware has been PC-Write. It is a menu-oriented word processing-like system. For an old hacker like me, learning a new convention after having used WordStar with all its control functions was not all that difficult. For more information on PC-Write, contact: **Quicksoft,** *219 First North 224, Seattle, WA 98109; (206) 282-0452*

Finally, for those of you who might be interested in an electronic spreadsheet, there is FreeCalc. This is similar to VisiCalc, with the ability to make only global changes in configuration. It's not a bad system, but it does not compare to the current list of heavy hitters like Lotus 1-2-3. For more information, contact: **Stilwell Software Products,** *16403 N. 43rd Drive, Glendale, AZ 85306.*

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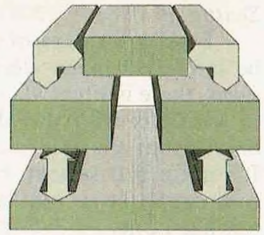

The UNIX File

Portability of UNIX software, a UNIX tally, and services on the net

by Ian F. Darwin

While you are reading this, the USENIX Association is having a technical forum in Salt Lake City, June 12-15. I'll have some details on this in a later column. Meanwhile, we answer some readers' questions about the size and shape of UNIX, then look at a book, some booklets, and a phone directory for UNIX users.

So many versions of UNIX . . .

Barry Shinberg of Dover, New Jersey wrote in to express his concern about the different versions of UNIX available, in particular about the portability of software from version to version. There are many, many versions of UNIX in use today. A complete family tree is beyond the scope of this column, but Figure 1 shows a quick version.

As you can see, there are many variants and UNIX-clone systems: The variants contain code derived from Bell UNIX; the clones are independent rewrites of the system. There are also several systems which try to capture the flavor of UNIX, such as QNIX, OS-9, and MS-DOS 2/PC-DOS 2.

The Research people originated UNIX, and still are truest to the spirit of UNIX. Development adds many features, and sometimes seems to be trying to turn UNIX into a cross between CP/M and MVS. Berkeley turns loose dozens of graduate students to hack at the system, introducing many changes, some beneficial and some foolish, before releasing it to the public.

But it is still true that the three families of Bell-derived systems (Development, Research and Berkeley) have enough in common that a user can move from one to another and still be able to do useful work (albeit with a few surprises from time to time). All offer the same shell (Bourne shell; some include *csh* as well), the same set of commands (**ls, mv, cp, rm, passwd,** and a couple of hundred others) with minor variations. Not shown in the diagram is the considerable cross-pollination between versions over time: good ideas prosper, bad ideas are dropped—usually. Occasionally good ideas from Research fail to make it into Development's production systems; this is the triumph of marketing over utility (witness **grep -y**, a useful option missing from Systems III and V). And the programmer has somewhat more work to do in moving from one family of systems to another.

But the good news is that well-written software can be moved quite easily from one version of UNIX to another. If the software is written in C and has been tested with **lint**, then there is a good chance that it will move from one UNIX to another. Exceptions include programs that depend upon interprocess communication mechanisms (there are several) or upon the specifics of the terminal driver (communications interface) that differ from one system to another. If the software is not written in the C language, then a compiler may have to be moved, then the applications. C is always available on UNIX, although some micro ports charge extra for the C compiler, and indeed for the normal system commands—caveat emptor!

How many UNIXes?

This is a frequent question. Sally Statton of Sunnyvale, CA writes: "I read one estimate in *Computer Decisions* quoting an AT&T vice president who said that approximately 700,000 computers of 70 different types are running UNIX. My question to you is: what are

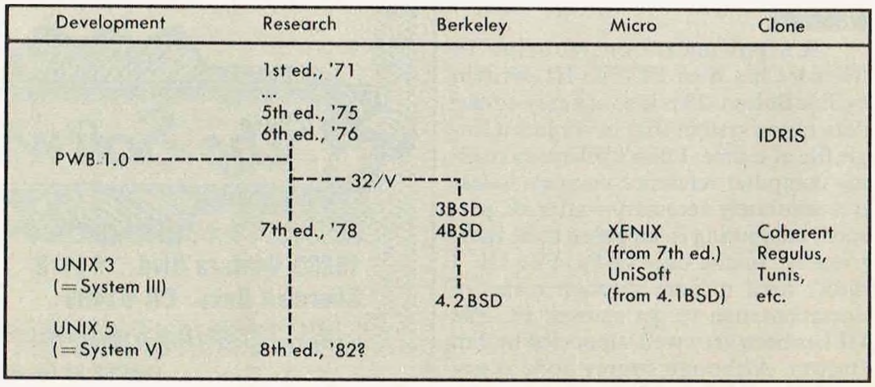

Figure 1. UNIX family tree—an abridged version.

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THE UNIX FILE

Continued from page 24

those 70 types of computers now running UNIX? Also, what companies are now supporting UNIX as an operating system on what CPUs? I have searched for some sort of centralized work in this area, and have not found any."

I'm not familiar with the article cited, but my personal opinion is that the estimate of 70 different types may be low, and that the number is actually closer to a hundred. The /usr/group UNIX Catalog mentioned in the April 1984 column contains listings of a large number of vendors of UNIX systems. They do not provide a separate listing of "systems," and it's difficult to derive an exact answer for the number of different ones, since some systems are sold under more than one vendor's label. I think the final answer may be that nobody knows exactly how many UNIX systems there are. The number of 700,000 should be fairly reliable, say plus or minus 100,000 due to reporting delays, since AT&T is the licensor (directly or indirectly) for all UNIX licenses. That figure would not include, however, the close-to-UNIX systems such as Coherent, IDRIS, and others. With these included, the total could well come to almost a million. If there is sufficient demand from readers, we could probably compile an up-to-date listing of system vendors similar to the software listing that ran in the April issue.

This book is not about UNIX

Operating Systems: The XINU Approach by Douglas E. Comer (Prentice-Hall, 1984) is not about UNIX. However, it will be of special interest to people interested in UNIX from a technical point of view, but unable to access the UNIX source code. As the title suggests, this is a university-level operating systems text, and you must know some programming in order to understand it. The book is not for the UNIX word-processing or spreadsheet user. But for the person who knows UNIX and C, or at least a high-level language such as PL/I or maybe Fortran, the book offers much illumination on how operating systems work. And it is a real treasure trove for UNIX fans, as it includes the complete source for XINU, a "demonstration" operating system modelled after UNIX. *XINU is not UNIX.* But the similarities are significant. Not surprising, considering that Comer worked on Bell Labs UNIX for years.

XINU runs "standalone" (with your program) downloaded into a micro connected to a UNIX timesharing system, rather than as a timesharing system itself. But XINU is a complete operating system. The book includes complete information on how an operating system such as XINU—or UNIX—is put together. The system is built up using an LSI-11 microcomputer with hard disks and a network interface. The important topics of runtime environment, list and queue manipulation, process and memory management, scheduling and interrupts, device handling and networking are all covered. There is also a description of the XINU file system and details on configuring a XINU system (as well as why you might want to). No attempt is made to cover all possible ways of doing these things. Rather, in Comer's words: "Instead, it shows the implementation details of one set of primitives, usually the most popular set. . . . Our goal is to remove all the mystery about how primitives can be implemented on conventional hardware. Once the essential magic of a particular set of primitives is understood, the implementation of the alternative versions should be easy to master."

Bell UNIX systems still have enough in common that a user can do useful work.

If you want to play with XINU, the source code is available on tape from the publisher. The ordering information is not given in the book, despite repeated mention of its availability. If you wish to order the tape, contact James F. Fegen, Jr. at College Editorial, **Prentice-Hall, Inc.,** *Englewood Cliffs, NJ 07632, phone 201-592-3122.*

Overall rating: very good.

Reference cards revisited

Ted the mailman recently brought me a handful of reference cards from Specialized Systems Consultants. The UNIX Command Summary and C Library Reference are customised for System III UNIX. Irene Pasternack of SSC writes: "We are in the process of writing a System V/4.2BSD Command Summary. This booklet will be available in July 1984."

The C Library Reference booklet is a summary of the system calls and STDIO routines used for programming in C on UNIX. For a long time I thought this would be a useful thing to have, since I could never remember which routines returned EOF and which returned NULL, and in what cases. Now that I have a reference card, however, I have memorized the common return values (actually there's a simple pattern to it), and I tend to refer to the actual manual more than the reference card. Usually when I can't remember something it's sufficiently obscure that I really need the manual. Certainly if the manual isn't where you are, and you don't want to carry the full manual set, this would be a very good buy for the UNIX programmer.

I don't use *vi.* It's an only-partly-successful attempt to build a screen editor without the overhead of a full-screen editor. But in its design stages, the need for simplicity was overlooked. Hence SCC's *vi* reference card is eight panels long, while their description of all the subcommands for the standard *ed* is only one panel long. But if you use *vi,* you probably *need* a reference card, so this one ought to be useful. The only nit I can pick here is that the symbol for the caret "^" and the symbol for CONTROL/letter are quite similar and might be confused when you're in a hurry. But that's as much a reflection on the design of *vi* as on the typesetting here.

The Command Summary says that it "includes commands accessible to the normal user; maintenance, graphics and superuser-only commands are not included." This card is quite well done, and the rule given has been followed for the most part. But there is a small amount of material that could profitably be excised. These little oversights make it appear that the person who extracted the material from the System III manual set did so rather more mechanically than with understanding. The **kas** and **kun** commands, for example, are included here, even though they only exist on VAX or PDP-11 systems, and are only of use if you intend to reprogram the KMC-11 programmable communications controller. Hardly the thing for a naive user to undertake! And the **rmail** command is listed, although it is intended for use only by the **uucp** program—it is not for human use.

All in all, however, a credible job. If you want reference cards for use where you don't have a manual set handy, get in touch with **SSC** at *Box 7, Northgate Station, Seattle WA 98125-0007; phone 206-FOR-UNIX.*

Finding UNIX people on the net

In a previous column I talked about some of the services on the net. Often, though, you are faced with a more mundane matter: how to find a **uucp** address

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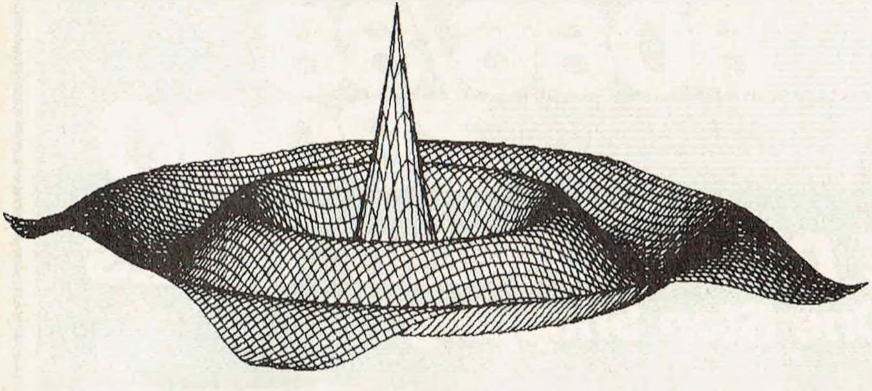

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CIRCLE 126 ON READER SERVICE CARD

THE UNIX FILE

Continued from page 26

to reach Betty Borris at the Charming Computter Company. Here's a directory of people who can be contacted via the **uucp** network of UNIX sites. This material is excerpted from a release sent out by the distributor, Intelligent Decisions, Inc. (IDI for short).

The first issue of the *uucp Network Directory* was published in early May. The price is $10.95 if you are either listed in the directory or if you provide enough information to be listed in the next issue (the minimum required to be listed is your name and a valid **uucp** address). If you don't want to be listed, or if you don't have access to **uucp**, the price is $15.95. You must include your **uucp** address with your order to qualify for the $5 discount. There is $1.25 shipping and handling, and sales tax in California. Subscriptions are available for $39.95/year if you're listed, $59.95 if you're not, including shipping and handling (plus tax in CA)—that's for four quarterly issues. They will not knowingly provide copies of the *Directory* to potential abusers.

The first issue has about 1000 people listed and is over 30 pages long. It is typeset in 5.5" x 8.5" format. The entries consist of people's names and **uucp** addresses, and optionally their work phone, home address, home phone, and one line about them. IDI is hoping to provide some site and route information in future editions—the exact timing and content depends to some extent on the public domain mapping efforts now underway by Rob Kolstad, Scott Bradner et al.; contact **cbosgd!uucpmap**.

Orders should be sent to the following address (no purchase orders, please, except by special arrangement): **Intelligent Decisions**, *Inc., Directory Order, P.O. Box 50174, Palo Alto, CA 94303; Phone 408-996-2399.*

That's all, folks. Please feel free to write in with questions or comments. Addresses for regular mail and electronic mail are given in the box. I can't always answer immediately, but I will get back to you. And I'm always glad to hear from readers with comments either on the column itself or on their reactions to particular UNIX systems or products. ◼

The UNIX File looks at many aspects of the UNIX operating system. If you have comments or questions about UNIX or this column, feel free to write to Ian Darwin at Box 603, Station F, Toronto, Ontario, Canada M4Y 2L8. If you have UNIX mail access to the **uucp** *network, you can contact Ian Darwin at* **ihnp4!darwin!ian**.

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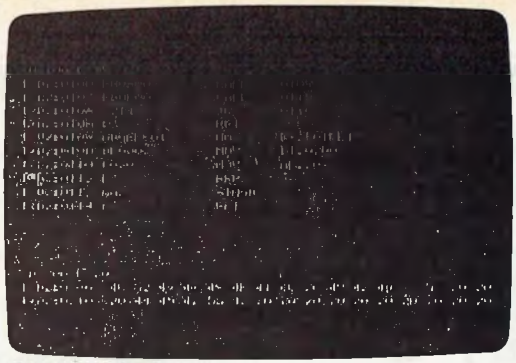
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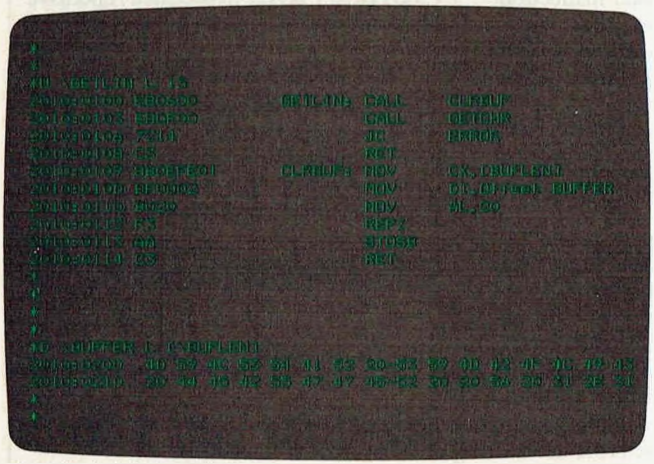
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The CP/M Bus

Using the NMI with DDT, by Gregor Owen; and a brief review of the CP/M Companion by Chris Terry

Editor's Note: Gregor Owen appears as a guest columnist to fill in for Randy Reitz, who was in process of moving across country when our July issue was being made up. Randy will be back next month.

In many Z80 systems, it would be nice to use the NMI (Non-Maskable Interrupt) for a pushbutton breakpoint when debugging programs. This would allow us to interrupt a program running under test at any convenient point, automatically entering DDT so that we can inspect registers and flags to get some idea of what the program is doing. When tracing and register inspection are completed for the moment, we should then be able to use the DDT "G" instruction to resume program execution. I had heard of this being done, but only recently figured out for myself how to do it while debugging a program at Satellite Transmission Systems in Happauge, N.Y.

Listing 1 contains the code for the NMI handler. It was assembled with Ithaca Intersystems' ASMBLE/Z, an "8080-type" Z80 assembler. This handler should be left as a hex file; use DDT to load the program under test *firstro;* only after this has been done should the NMI handler be loaded. This sequence is necessary because the NMI handler has to use location 66h (the NMI vector), which also happens to be the CP/M default File Control Block area, used by DDT to load programs. Thus, if you try to load the handler first, DDT will overwrite part of it.

You should also make sure that the program under test does not use this area—it should do file I/O without using any of the CP/M default areas. Also, keep a sharp eye on the target program's stack area; some programs set the stack pointer at 100h, and if nesting goes deep enough, the stack may collide with part of the handler code.

Programs that use normal interrupts will almost certainly have problems, but this is true of any attempt to debug using DDT. When you enter DDT, there is no way to tell whether interrupts were enabled or disabled; for this reason, DDT always disables interrupts when invoked. I don't know what it does upon exit, but it's sure to be wrong sometimes. The only remedy would be to create a version of DDT in which all EI and DI instructions were removed, but then an interrupt-driven program would be able to interrupt DDT itself, which would create new problems. In any event, the code in Listing 1 should work with interrupt-driven programs, provided that you can straighten out DDT.

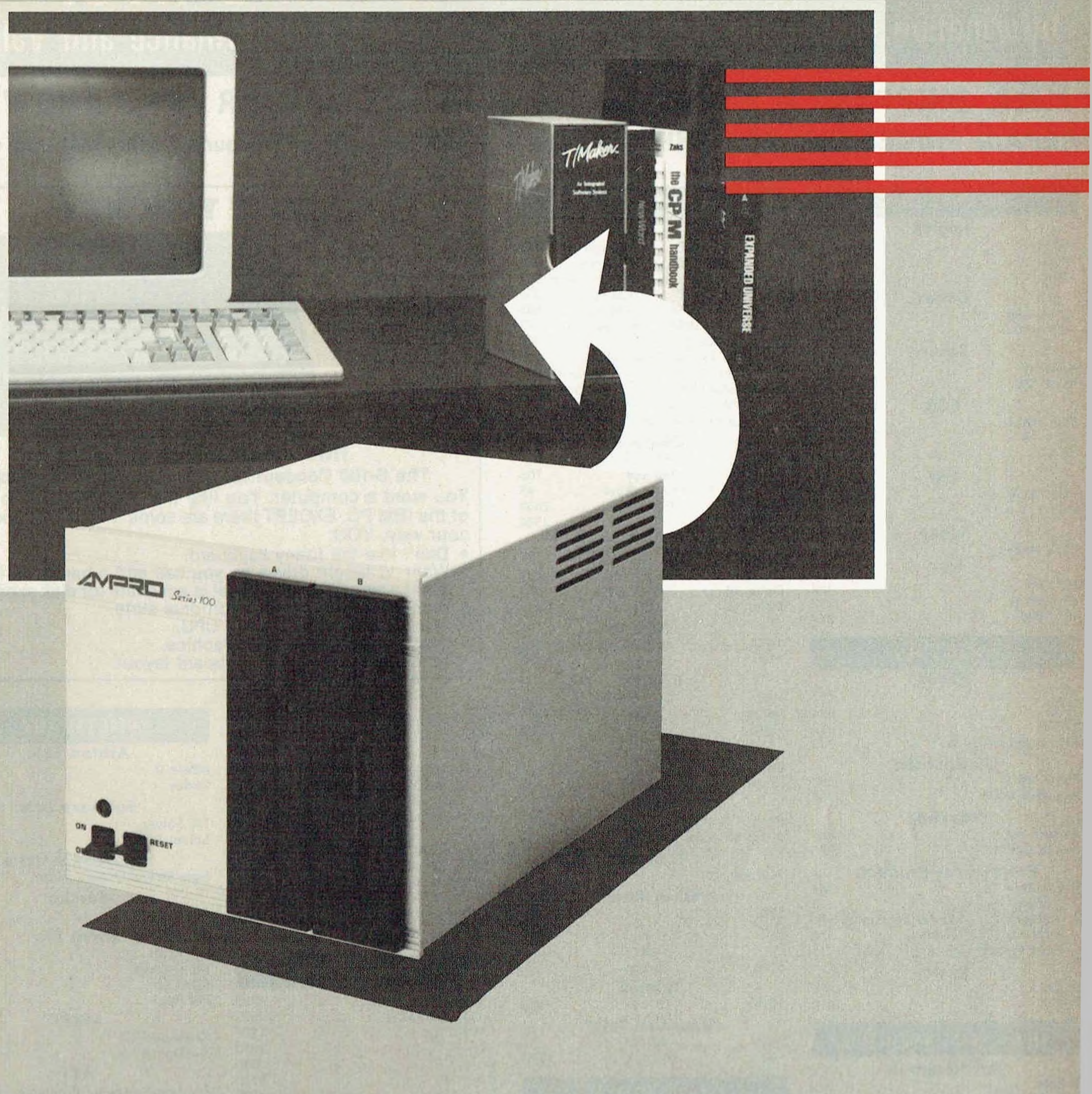
As in most breakpoint arrangements, the target program must be able to provide some additional stack space. The NMI handler requires up to 6 bytes of stack; DDT uses no stack space except for the breakpoint, which is included in the 6 bytes for the handler.

This scheme does have some minor annoyances, described in the comments to the code, which may result in the pushbutton being ignored if the NMI occurs at the wrong time or place. However, it's OK to press the pushbutton repeatedly until you get a break, because extra NMIs should be ignored once inside DDT. Indeed, one enhancement might be the addition of an oscillator (500 Hz to 1 KHz) to produce repetitive NMIs for as long as the button is held down.

Even with the problems and restrictions described above, the NMI scheme is very handy for certain kinds of debugging. For instance, it often happens that a target program runs correctly for a while, and then starts misbehaving. It is difficult to convince DDT to start breakpointing at that time, but not before, because you probably have no means of telling where to put the breakpoint. With the NMI scheme, you can wait until misbehavior starts, push the button to get into DDT, and then set a breakpoint to catch the erring program at its deviltry!

Using the NMI scheme you can set a breakpoint with DDT and catch an erring program at its deviltry.

The hardware is simple, and consists merely of a debounced pushbutton, as shown in Figure 1. Unused inputs should be tied high through a pullup resistor (1K for a 74xx chip, 5K for a



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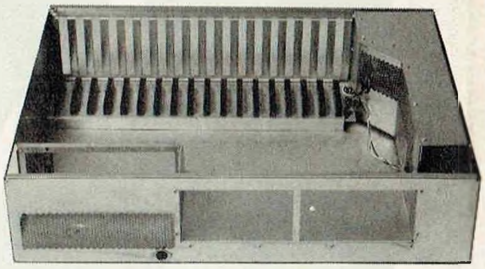

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CP/M Bus

Continued from page 30

74LSxx chip). If you have two unused sections of a NAND chip (7400, 74LS00), you may not need to add any hardware at all.

As a demonstration of the kind of sneaky measures one can take to deal with special problems, I have provided conditional code to check the stack location of the program under test, depending on the setting of the STKCMP equate. We want at all costs to avoid breakpoints of any kind within DDT or the BDOS itself. These programs are not re-entrant, so we want to skip NMIs that occur in the wrong place; that is, we must do an immediate return without going to DDT. One way to do this is to check the break address (the content of the program counter that NMI stuffs on the stack) and make sure that this address is *below* the address contained in locations 6,7 (the standard entry point for BDOS or, in this case, DDT). When STKCMP is FALSE, the code compares the break address with the entry point address. When STKCMP is TRUE, the code checks the location of the stack pointer of the program under test. This solved an unusual problem en-

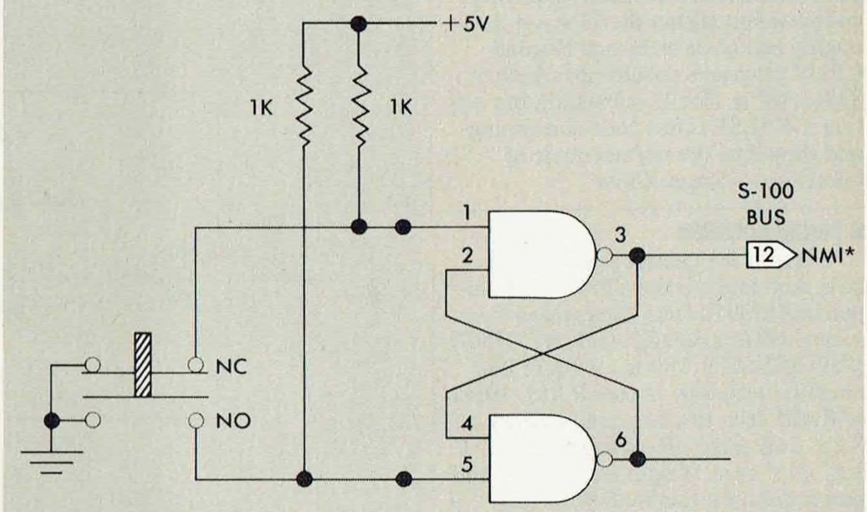

Figure 2. Debouncer, using spare 7400 sections

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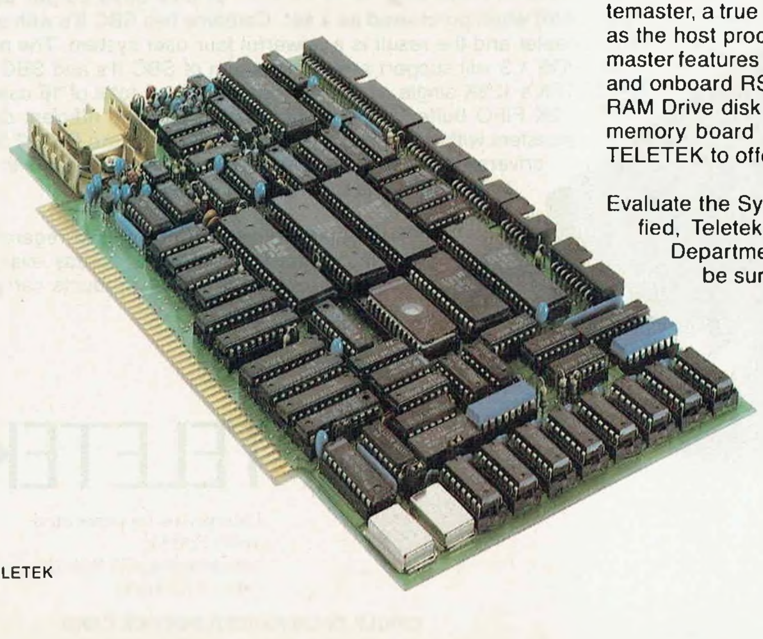

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CP/M Bus

Continued from page 33

countered when the program under test actually modified the BIOS so that a particular BIOS call ended up calling code resident within the TPA—a thoroughly bad piece of design! Normal CP/M programs should run whether STKCMP is TRUE or FALSE, but setting it FALSE is less code-consuming and should be the normal mode of operation.—*Gregor Owen*

A handy portable

One of the neatest machines we have seen lately is the CP/M 2.2 Companion ($1095), from *Companion Computers, PO Drawer CC, Apex, NC 27502; (919) 362-6655*. This is a 4-MHz Z80 machine with 64K of user RAM, 192K of RAM disk, and one quad-density 5.25″ disk drive, all packaged in a 7″ x 3.5″ x 14″ case. Weight is only 8 lbs, and power consumption is 40 W at 120 VAC. There is a convenient carrying handle on top of the case.

Four I/O ports are provided: two serial RS-232C ports, one for a terminal and the other for a modem or hardwired connection to a host computer; both of these run at up to 19,200 baud. There

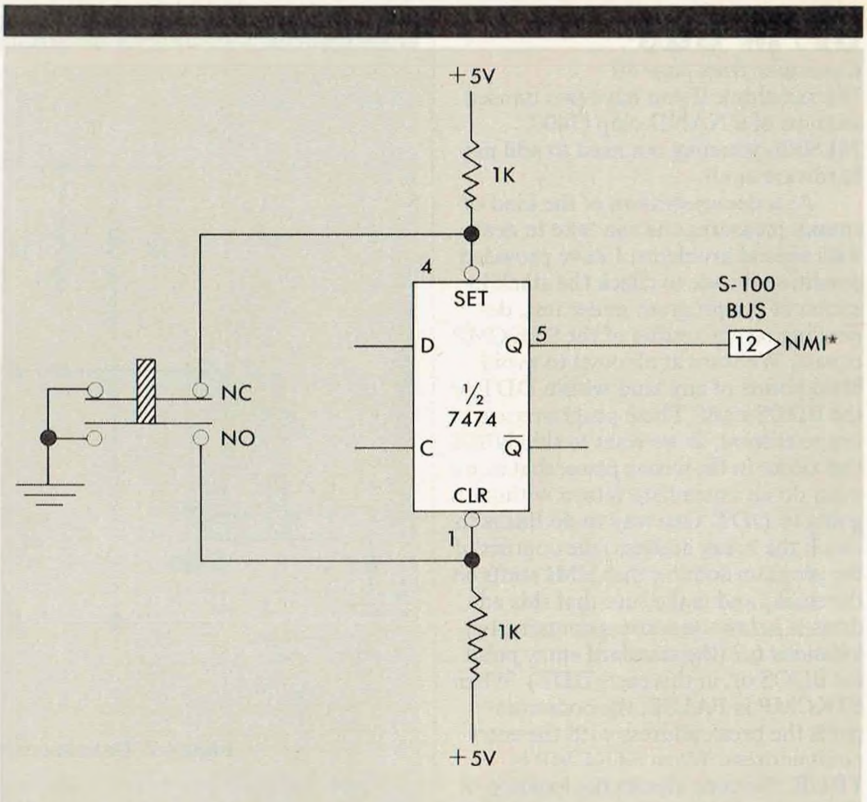

Figure 1. Debouncer, using 7474 chip

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Four Users In a Three Board System? TELETEK can do it! And at only $599.25 per user (complete) when purchased as a set. Combine two SBC II's with one Systemaster and the result is a powerful four user system. The new TurboDOS 1.3 will support any combination of SBC II's and SBC I's (TELETEK's 128K single user slave board) up to a total of 16 users. The 2K FIFO buffer provides each user with fast, efficient data transfers without reducing available TPA. Onboard RS232 SIO drivers make packaging neat, clean and inexpensive with no costly and cumbersome paddle boards.

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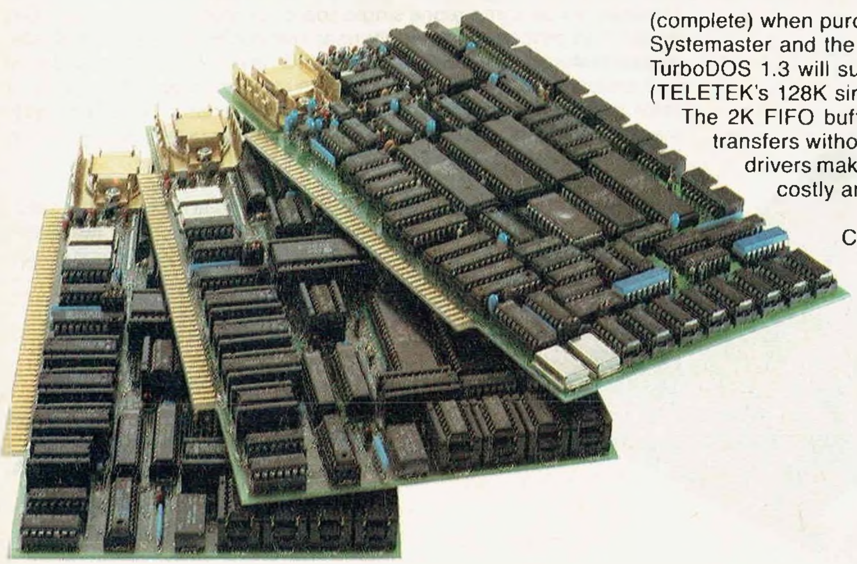

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are also a Centronics parallel printer port and a bus port for connection of external disk drives and other peripherals.

This little gem is meant to be carried around and used wherever there is a terminal or another computer. It normally uses the Morrow disk format, but can read from and write to IBM (154K), Kaypro and Osborne disks formatted on their host machines. Software provided with the machine includes not only the standard CP/M utilities, but Basic, a print spooler, redirection of print output to the parallel or serial ports, and a communications package for transferring data between the Companion and a host computer. This program is simple-minded, but transmits/receives 128-byte blocks with a form of error detection.

Software provided in ROM (configured as the B: disk drive) includes SWEEP (a general disk file management utility), a backup facility, and a terminal mode that can log all transactions in a disk file. A configuration program lets you set your port characteristics and control/escape sequences to suit your terminal.

We consider the CP/M companion a very good buy, and very easy to use.—*Chris Terry*

LISTING 1

```
        0000        FALSE    EQU     0
        FFFF        TRUE     EQU     NOT FALSE
        0000        STKCMP   EQU     FALSE

        0000                 IF      STKCMP
                             ORG     64H             ;GET A LITTLE STORAGE SPACE
                    STACK:   DS      2               ;TO PUT THE STACK.
                             SSPD     STACK          ;THIS IS THE NMI VECTOR (66H).
                    ;SAVE THE STACK IN MEMORY SO WE CAN LOOK AT IT.
        FFFF                 ELSE
                             ORG     66H
                             ENDIF

0066    E3                   XTHL                    ;hL GETS BREAK ADDRES, STACK GETS HL.
0067    F5                   PUSH    PSW             ;SAVE A, FLAGS
0068    3A 0007              LDA     7               ;GET MSB OF CP/M LOCATION
006B    3D                   DCR     A               ;FIX UPFOR COMPARE

        0000                 IF      STKCMP
                             PUSH    H               ;SAVE HL
                             LHLD    STACK           ;GET STACK
                             CMP     H               ;COMPARE CP/M WITH STACK.
                    :                                (CPM/256)-1 MINUS STACK/256.
                             POP     H               ;GET H BACK
        FFFF                 ELSE
006C    BC                   CMP     H               ;COMPARE CP/M WITH BREAK
                    :                                (CPM/256)-1 MINUS BREAK/256
                             ENDIF

006D    30 04                JRNC    OK              ;CPM > BRK OR STK
006F    F1          NOTOK:   POP     PSW             ;NOT OK, RETURN WITHOUT BREAK
0070    E3          BIP:     XTHL                    ;STAK GETS BRK, HL RESTORED
0071    ED 45                RETN                    ;RETN WILL RESTORE STATE OF INTERRUPT ENABLE
                    :                               WHERE WE WERE NMI'D

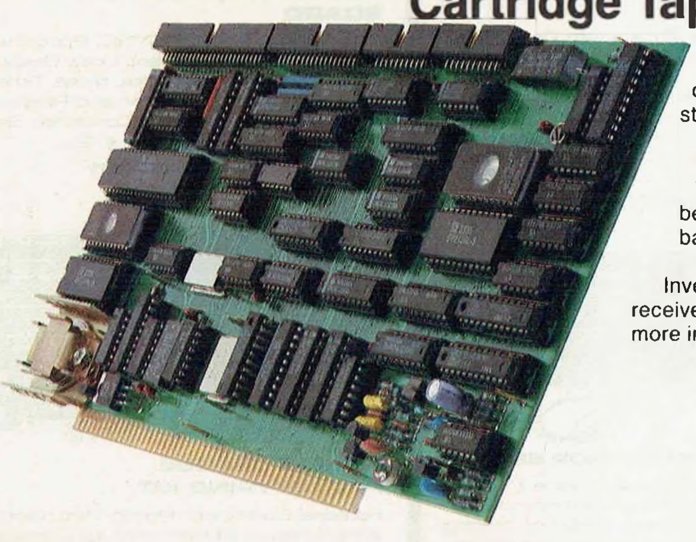
0073    2B          OK:      DCX     H               ;DDT CHECKS FOR RST7 (0FFH) AT BREAK-1
0074    7E                   MOV     A,M             ;IF BREAK-1=RST7, THEN DDT DECREMENTS
0075    23                   INX     H               ;THE BRK ADDRESS BECAUSE IT THINKS IT
0076    FE FF                CPI     0FFH            ;IS A USER BREAKPOINT. THERE'S NOTHING NMI
0078    28 F5                JRZ     NOTOK           ;CAN DO ABOUT THIS, SO WE SKIP IT.

007A    F1                   POP     PSW
007B    E3                   XTHL                    ;STACK GETS BREAK, HL GETS ORIGINAL CONTINUATION

                    ; JRZ    38H    WE CAN'T DO THIS.  IT SEEMS AS IF
                    ; THE Z80 GETS CONFUSED IF IT GETS A SECOND NMI WITHOUT THE
                    ; FIRST ONE BEING ''RESTORED'' WITH A RETN.
                    ; THE FOLLOWING CODE WORKS
007C    E5                   PUSH    H               ;ORIGINAL CONTENTS OF H ON STACK.
007D    21 0038              LXI     H,38H           ;DDT'S ADDRESS IN H.
0080    18 EE                JR      BIP
```

TELETEK SYSTEMANAGER

One HD/CTC Controls Both Hard Disk and Cartridge Tape Drives.



The TELETEK HD/CTC features a hard disk and cartridge tape controller, both on one S-100 board. This intelligent, two-function controller will support any two ST506 compatible Winchester disk drives and the full range of QIC-02/QIC-24 compatible streaming tape drives.

If a hard disk controller is required, the TELETEK HDC is ideal. The HDC will operate in any S-100 environment and can even be upgraded to a fully functioning HD/CTC should cartridge tape backup be required at some time in the future.

Invest in the TELETEK HD/CTC (in first column quantities) and receive the Systemaster for only $399. Call our Sales Department for more information on this special offer.

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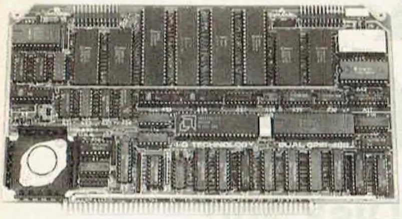

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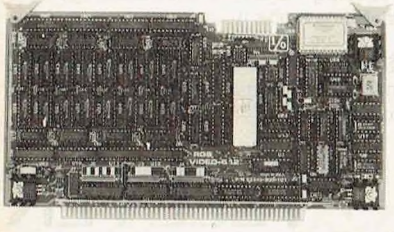

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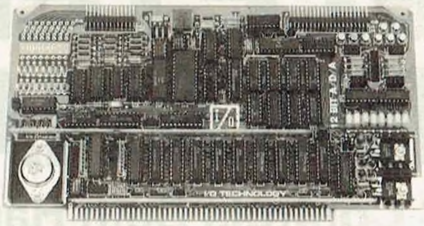

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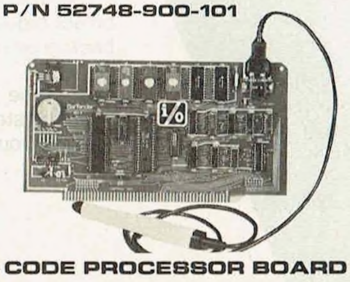

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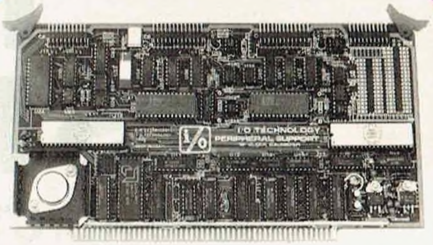

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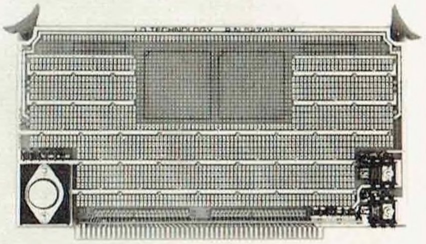

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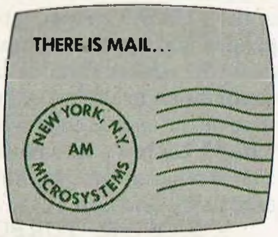
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Letters to the Editor

This month... VectorScan enhancements; JRT and TURBO Pascal compared

Dear Sir,

I have read Ron Lusen's product review of the VectorScan 512 graphics controller, appearing in this issue. It seems that Mr. Lusen has tested and evaluated the unit thoroughly and has brought the relevant issues to the surface in his article. It has been approximately one year, however, since he first received the VectorScan, and a number of enhancements have been made since then. A notice of the last revision date has been included in the front of the manual, and several enhancements have been made to the VectorScan firmware.

The firmware enhancements include binary and continuation command modes, increased drawing speed for certain primitives, additional screen clear modes, and a new printer driver. The binary command mode is a second mode for invoking VectorScan primitives; it uses a more efficient binary command structure. (Note that this mode has been added as well as the standard ASCII text mode. Also, the binary command structure is such that the characters still remain in the printing ASCII set, thus avoiding control code trapping.) The continuation mode allows such things as "poly-vectors" and quick loading of the color pallete. The full screen clear time has been reduced to under one second, and the vector drawing speed has been increased by 40%. The clear screen primitives now allow clearing (or setting) of rectangular portions of the screen as well as individual bit planes. The new printer driver, for hardcopy screen dumps, is for Radio Shack's CGP-220 color ink jet printer.

Using the VectorScan's new binary command mode with poly-vectors and the 40% increase in vector drawing speed, the back panel layout can now be driven in less than four seconds (compared to the eight seconds reported in the article).

Also, please be aware that the 8" disk of VectorScan demonstration files is not included with the unit. A VectorScan demonstration disk is available in various formats to run in either a CP/M 2.2 or Apple DOS environment for a handling and media charge.

Lance B. Jump
Vice President
Applied Data Systems, Inc.
9811 Mallard Drive, #213
Laurel, MD 20708

Dear Sir,

Regarding the article on TURBO Pascal by David Carroll (February, 1984): I recently bought Borland's TURBO Pascal, having used JRT Pascal for over a year. My observations largely coincide with those of Mr. Carroll. My first use of TURBO Pascal was to convert a stock quotation plotting program originally written in JRT Pascal, which used JRT's JGRAF routine. During the conversion process, I noted the following differences between JRT and TURBO Pascal:

1. File assignment: JRT does assignment to filenames in the rewrite and reset statements and allows specification of buffer size for the I/O. TURBO requires an extra assignment statement. I found that TURBO's file I/O was approximately as fast as JRT's even without the ability for the programmer to specify a buffer size.

2. List output: JRT uses calls to a system function to turn on/off output to the LST: device, whereas TURBO requires the 1st standard file identifier to output to the LST: device. Thus it is easier to output simultaneously to the printer and console in JRT Pascal than in TURBO Pascal.

3. Hex constants: JRT uses the format nH, whereas TURBO uses the format $n for hexadecimal constants. Although I find the JRT notation more intuitive and more consistent with CBasic, various assemblers, etc., it is really a matter of style rather than substance.

4. External procedures/functions: JRT has a linker and the programmer can declare a procedure/function as external. TURBO, on the other hand, has no linker or external routines, but does have a good "include" facility with the ability to chain other routines, which is (in effect) an overlay facility. I did find, in my conversion exercise, that a program which required linking and overlaying in JRT Pascal could easily fit in my 64K memory using TURBO Pascal, with plenty of room to spare.

VS512's vector drawing speed has been increased by 40%.

5. Pointer variables: JRT allows a pointer variable to point to any type of variable, so that pointers to variables of a different type may be assigned to each other. TURBO, however, will give a

LETTERS

Continued from page 37

type mismatch error in this case, since it requires that the type of variables pointed to be the same. Although it is occasionally awkward, TURBO's treatment is not a serious difficulty.

6. *String handling:* This situation is much like the treatment of pointer variables. JRT allows strings of different declared maximum lengths to be assigned to each other and to be passed to and from routines. TURBO again gives a type mismatch error in this case and requires that the declared maximum length of the strings be the same. Also, JRT allows a maximum string length of 64K characters, whereas TURBO's maximum string length is 255 characters, which is a minor restriction.

7. *Formatting of real output variables:* JRT prints a real variable with zero fractional part as an integer in its default format, whereas TURBO prints all reals in floating-point format. I found the JRT default formats to be good enough, so that TURBO causes some extra care when handling output formatting. However, both JRT and TURBO provide sufficient formatting capability to handle this problem.

8. *Tabs:* Since the programmer creates source code for the JRT compiler using an external editor, horizontal tabs pose no problem for most editors. However, since the editor is an integral part of the TURBO system, tabs are not expanded and appear as highlighted when using the editor. This does not affect the compilation itself, but only the appearance of the source code when editing. I found TURBO's automatic indentation a bit strange at first, but rapidly grew used to it—and now I even appreciate it.

9. *BIOS calls:* TURBO Pascal performs its terminal and printer I/O through calls to CP/M's BIOS rather than the more conventional BDOS. Although the interface for BIOS calls is supposedly standard across CP/M implementations, my SD Systems BIOS implements the call to the LIST BIOS function as outputting the value in register E rather than register C as is standard. This caused TURBO Pascal write statements directed to the printer to output garbage. I overcame this easily by changing the LstPrt procedure in TURBO Pascal to a call to the BDOS. This change was well documented in the TURBO Pascal manual and worked exactly as specified in the manual.

Overall, I found TURBO Pascal excellent. The memory resident compilation is *very* fast, even when generating a .COM file to disk. Execution speed is excellent also, since the compiler generates native machine code. These two features alone would make the TURBO Pascal superior to the JRT version, even if it were not for a final item: I have not yet found a bug in TURBO Pascal, whereas I have found a number in JRT Pascal. These compiler bugs caused me to spend considerable time and effort in debugging and programming. The lack of bugs in TURBO Pascal is, in my opinion, the single most important advantage of TURBO Pascal over JRT Pascal. I can only hope that other vendors will generate software as useable, well-documented, and bug-free as Borland has.

Donald C. Brabston
15573 Briarwood Dr.
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Dear Sir,

We're looking for a manufacturer of an optical recording device for storing archive digital information. We want to add data to the optical disk from time to time and to be able to read it back at any time. We realize we can't reuse any space on the disk; when it's full we start a new one. If any one has such a unit interfaced to either an S-100 or IBM-PC/XT system, please contact me.

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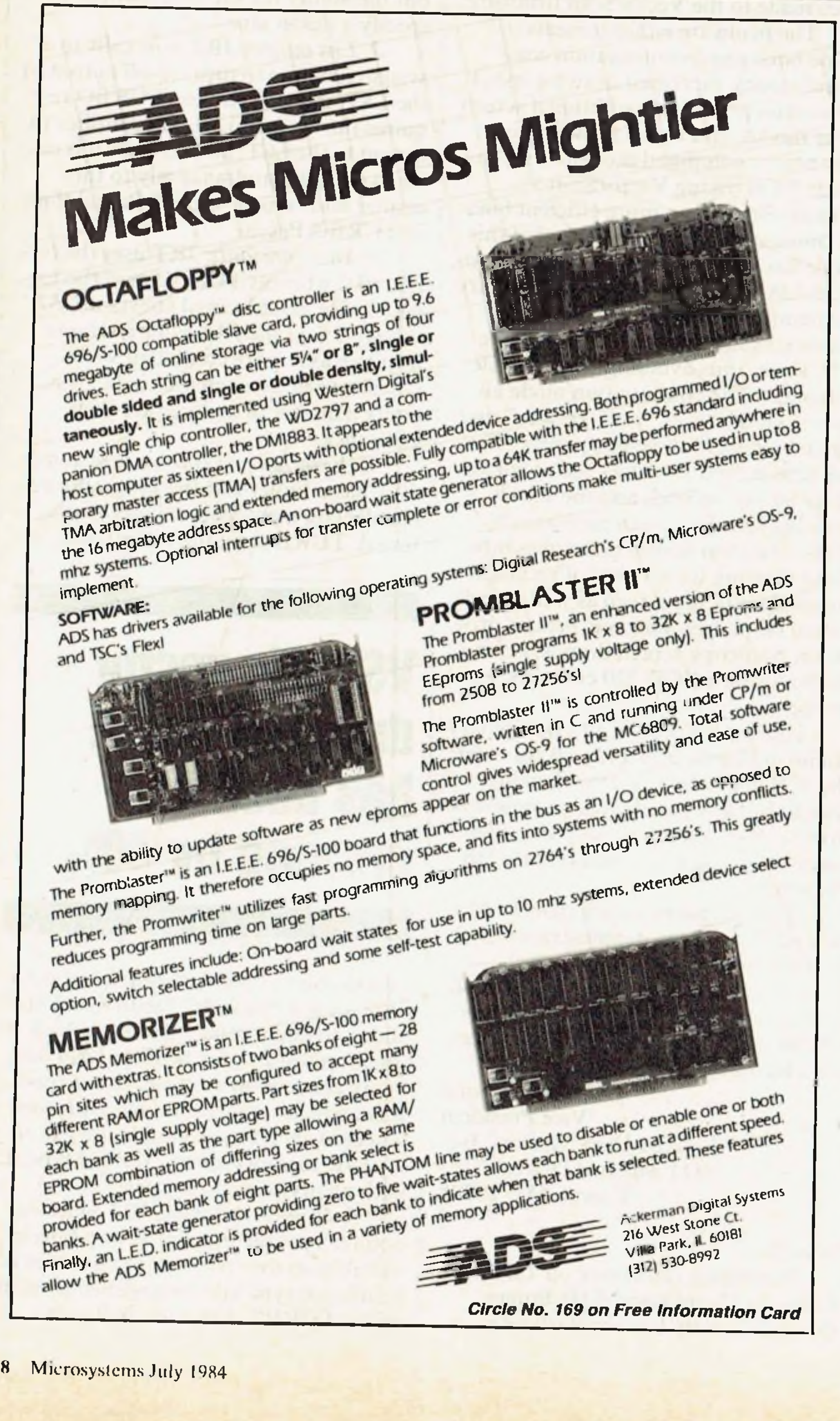

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File manipulation utilities

by Chris Terry

This month I shall be talking about file manipulation utilities. These fall into several classes: displays, verification, and review. Display utilities are, in general, substitutes for the CP/M TYPE command which does no paging and is inconvenient for screen use. Verification utilities include quick integrity checks such as computing a checksum, and also compare utilities that show details of the differences between two files. Review utilities access the disk directory and present one name at a time for user actions such as display, copying, erasure, etc.

Display utilities

DISPLAY (SIG/M Vol. 18) is a version of ED (the standard CP/M editor) with only the display commands left in. It is a little slow at first, because all of the TPA except the first 2K (occupied by DISPLAY itself) is used as a buffer for the file to be examined. It displays a number of lines (default = 22) on the screen; this number can be patched in the .COM file, or you can change an equate in the source and reassemble. Each time you hit the Return key, the next page is displayed, together with a blank line and the asterisk prompt for a new command. You can move through the file a line at a time (L, -L), a page at a time (Ret, -P), or n lines (pages) at a time (nL, -nL, nP, -nP). When you have finished, the E (exit or end) command gets you back to CP/M. Because of the slow initial loading, TYPE may be more convenient for a cursory look at a small file, but for detailed examination DISPLAY is ideal.

A similar bidirectional paging program is BISHOW, by Rick Conn (of ZCPR/SYSLIB fame) in SIG/M Vol. 145. BISHOW is available for both CP/M-80 and CP/M-86.

Verification utilities

For a simple check of file integrity after a disk copy operation, CRCK10/6 (CPMUG Vol. 63) provides a full 16-bit cyclic redundancy check of a file, or of all the data on a disk. If the CRC value on the destination disk agrees with that on the source disk, you have a successful copy; if no copy was done, then you have identical versions of the file on each disk.

For more detailed examination of differences between files, COMPARE (CPMUG Vol. 40) compares two binary files and lists the differences. On the same volume, CV compares two ASCII files and displays them line for line in two windows of a memory-mapped screen display. Although written for the 16 x 64 ProTech VDM-1 board, it might be adapted for other, display boards.

An even better comparison program is DF, written in C by Richard Greenlaw, who supplies it at a nominal fee (it used to be $15). This checks lines in each file and shows only the differences, resynchronizing when it again finds identical lines. It can be used with any kind of display.

A similar program, DIF2, is in contained in SIG/M Vol. 68; however, I have not used it and do not know just what features it has. It is in .OBJ form for transfer from an RCPM station, and there is an associated DIF2.RNO file; I have no idea what this contains.

Review utilities

Probably the best known utility of this kind is WASH, available on most RCPM stations. The latest version I have found is WASH16, on SIG/M Vol. 44, though since this volume was released a couple of years ago there may be a later version. This puts the directory into a circular file that is displayed on the screen, one filename per line. The cursor indicates the file to be worked on. WASH lets you display the file, copy it to another drive, rename it, or erase it. Other functions can also be performed. Hitting return just takes you round and round the circular file without any action, so that you can come back to a file and perform a second action on it. Erasure is indicated against the filename, but is not performed until you exit from WASH, so if you change your mind, you can recover a file marked for erasure with no problem.

A similar utility with even more features—that lets you run other utilities from within it—is Frank Gaude's DISK7, in SIG/M Vol. 127. This is a powerful and convenient tool, especially since it can be run from within Frank's communications package COMM7 (on the same volume.

Yet another screen-oriented file manipulation utility is Rick Conn's VFILER, which integrates with ZCPR2 or can be used alone. Vfiler is on SIG/M Vol. 145. I have not used this, but anything from Rick is likely to be both powerful and convenient.

The reason I have not fallen on these excellent utilities with glad cries of joy is that a year or two back I got my paws on POWER, from Computing! San Francisco, updated to v. 3.03. This replaces so many CP/M functions (DDT, STAT, PIP, DIR, ERA, REN, CRCK, FINDBAD, etc.) that I have no reason to use these others.

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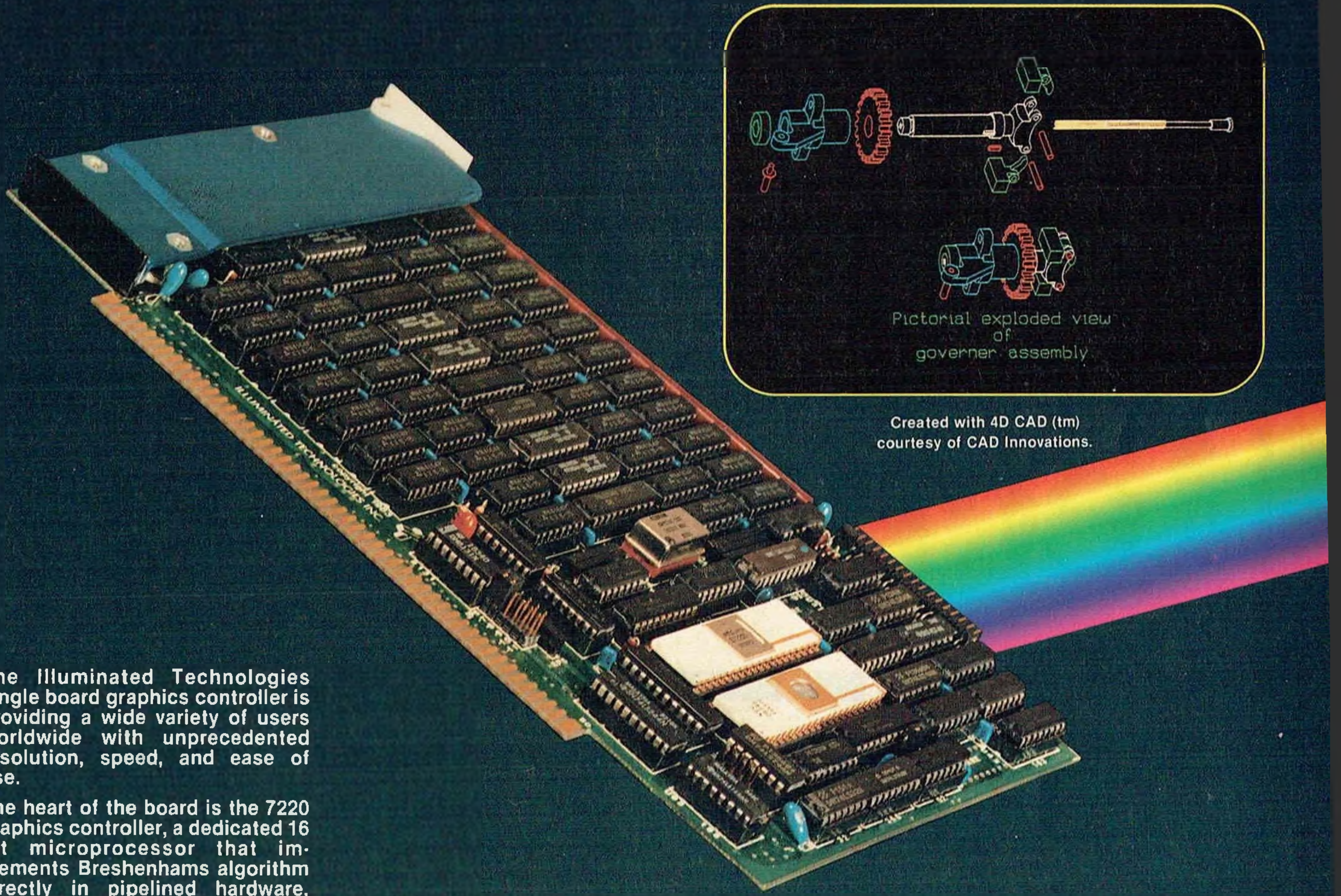

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Computer Graphics Technologies

An overview of current graphics output technologies

by Alan P. Matthews

Before we begin our discussion of computer graphics, it is important to talk briefly about the characteristics of human sight. Human sight is best described as a collection of subsystems that interact with each other. By interaction I mean, for example, that the color we see when we look at a chart or a picture depends not only on the wavelength of the light, but also its luminance (brightness), the area of color filled, the color and brightness of the surrounding area, and what you happened to look at just before you looked at the image. Other factors must also be considered, some of which depend on the individual. The study of the relationships between physical stimulus and the perceived stimulation is called *psychophysics.* I am not suggesting that you should take a course in psychophysics before you rush to your computer to create a pie chart. A few examples, however, may serve to show how complex the seeing process is, and may provide some thoughts on preparation before we rush into designing ad hoc graphics.

Preconceptions

When we look at something, whether it be a page of text or a view of a landscape, an incredible quantity of data is transmitted to our brain in a split second. Yet what we see and what the brain understands do not always match up. Consider, for a moment, that from earliest infancy we have been learning to see three-dimensional shapes from two-dimensional images as well as from the objects themselves. We have built up for ourselves a set of rules for matching the objects to their images. We have also, quite unconsciously, developed the habit of supplying data that are missing from the image or ignoring data that *are* there in order to make the image correspond more closely with our experience of the objects depicted. When the rules that govern the construction of the image depart from those we habitually use, we find ourselves confused. A fine example of this is to be found in a picture by Maurits Escher (Figure 2).

Foreground/background

Look at Figure 11. Which circle has the greater light intensity (luminance)? Perhaps you guessed it—both have identical luminance. The reason that the left-hand circle *looks* brighter than the other is that the left-hand background is darker than that on the right. When any retinal cell is excited by light of a certain brightness falling on it, this cell to some degree inhibits excitation of adjacent cells. The background on the

Figure 1. Highway No. 1.

left is below this threshold; the background on the right is above the threshold and therefore inhibits retinal excitation due to the circle.

Color sensitivity

The sensitivity of the eye is, not surprisingly, well matched to the spectral emission of the sun, peaking in the midrange of the wavelength span 400-700 nanometers. The color receptors of the eye are the cones in the retina, and there are three different types of cone. Different wavelengths of light produce different excitation levels in the three types of cone, one of which is sensitive mainly to red light, another to green, and the third to blue. The excitation levels of the cones, both in absolute quantities and relative to each other, produce the vast array of color sensations that we experience. However, the eye is not equally sensitive to all colors. The color bands in Figure 3 were generated in such a manner that they all have precisely the same intensity, yet the eye perceives different intensities (least in the blue, most in the red).

These are only a few of the physical and perceptual distortions that can change our understanding of what we actually see. Whole schools of art—notably those known as *trompe l'oeil* and *op-art*—have made deliberate use of these characteristics of human sight to achieve their desired goals. The message is clear: if a picture is worth a thousand words, be sure that the words make sense and that your image says what you mean!

> **If a picture is worth a thousand words, be sure that the words make sense, and the image says what you mean.**

CRT displays

The device currently used for all TV and computer-generated graphics is the cathode ray tube (CRT), which paints the image on a phosphorescent screen by means of a finely focused electron beam that produces a dot of light wherever it strikes the screen. In a monochrome CRT, the material gives off one color only (blue-white, green, or amber). In a color CRT, three phosphors are used, the particles being placed in triads on the screen; one phosphor gives off red light, another green, and the third red. Three electron guns are used, one for each color; a mask, with tiny holes grouped in threes, ensures that electrons from each gun strike only phosphor dots that emit the corresponding color. Getting the electron beam to strike only the intended phosphor dot and not an adjacent one is a complex manufacturing task. If there were no limit to the number of dots on the screen, there would be no limit to the resolution of the picture displayed—but unfortunately phosphor granule size and mask manufacturing difficulties do place a limitation on the number of dots available. The resolution of a TV tube is about 512 (horizontal) by 480 (vertical); this is classed as low resolution. Units classed as high resolution can have 512 x 512 dots, and one recent unit (of which only a prototype so far exists) has 1700 x 1280 dots.

Vector and raster displays

CRT display devices all fall into one of two categories, according to the manner in which they construct the image: vector displays or raster displays. A vector is merely a line drawn continuously between a starting point and an end point. The term *vector* is used because the movement involves both horizontal and vertical movement simultaneously; the total travel is the algebraic sum of the horizontal and vertical components. Thus, to define such a line, we must have a grid of points between which movement can take place. A circle can be drawn by a succession of very

Continued from page 43

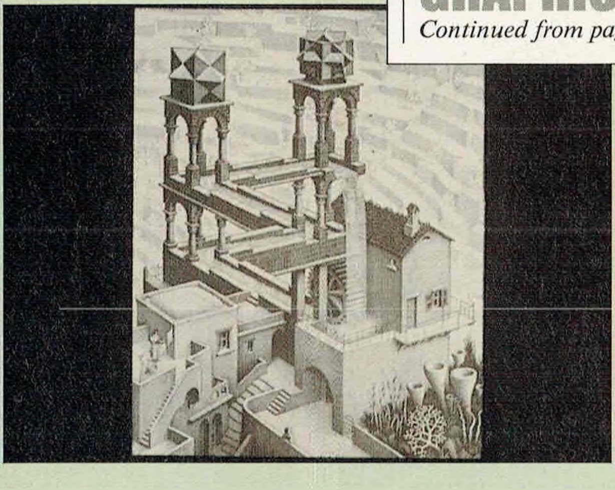

Figure 2. *"Waterfalls," by Maurits Escher, is an example of trompe l'oeil art.*

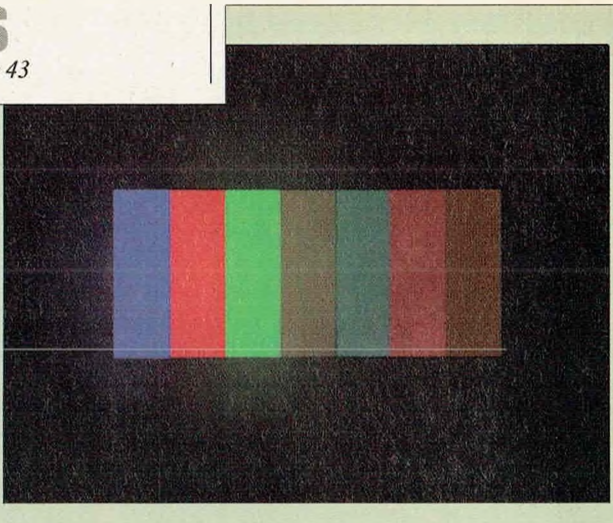

Figure 3. *All these color bands have the same intensity, but the apparent brightness of each is different.*

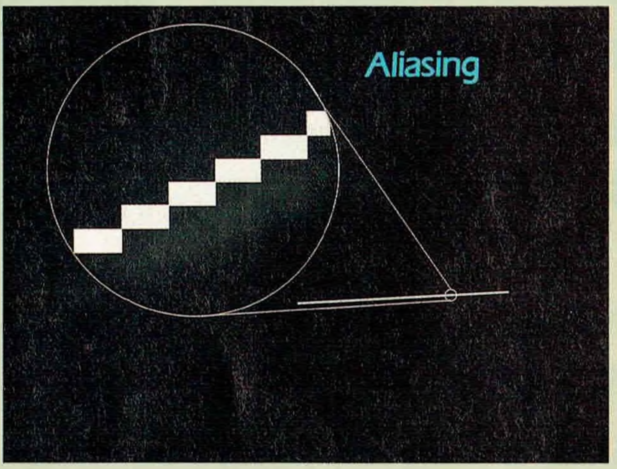

Figure 4. *A diagonal line drawn on a raster display exhibits a staircase effect called "aliasing."*

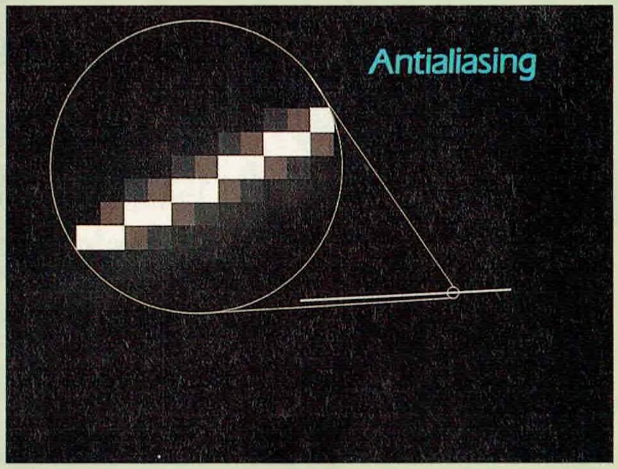

Figure 5. *Aliasing can be made less apparent by turning on adjacent pixels at a lower intensity.*

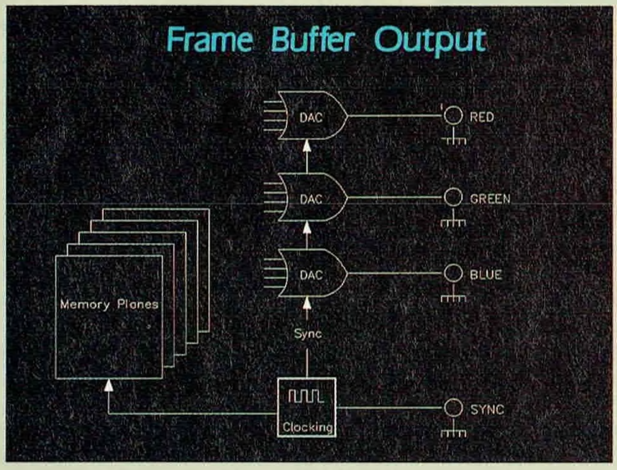

Figure 6. *Block diagram of RBG color video outputs.*

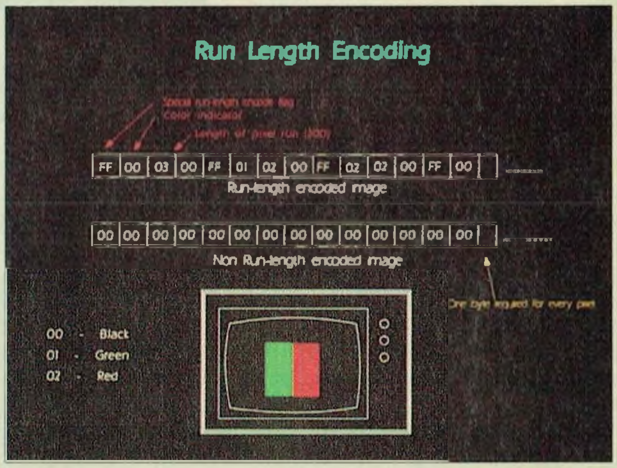
Run Length Encoding
Special run-length encode flag
Color indicator
Length of pixel run (300)
FF 00 03 00 FF 01 02 00 FF 02 02 00 FF 00
Run-length encoded image
00 00 00 00 00 00 00 00 00 00 00 00 00 00
Non Run-length encoded image
One byte required for every pixel
00 - Black
01 - Green
02 - Red

Figure 7. *Data compression by specification of the number of continuous pixels of the same color.*

Figure 8. Flowers

short lines; the smoothness of the circle then depends upon how close together the grid points are. Plotters are vector-generating devices, and so are some types of CRT displays.

Raster displays operate on a different principle: the electron beam continuously traces a slow horizontal path across the screen, with a rapid flyback to a point just below the start of the line just drawn. This process is repeated until the beam reaches the bottom right of the screen, when there is a rapid flyback to the top left corner, where the process begins all over again. During the slow horizontal lines, the beam may be turned on and off to produce dots that form part of the image; during the horizontal and vertical retrace times, the beam is blanked so that it cannot write on the screen.

It should now be evident that though a horizontal line may be continuous on a raster display, a vertical line is likely to be broken up into discrete dots whose separation depends on the number of lines drawn by the raster. A diagonal line will exhibit a staircase formation. This effect is called *aliasing*, and is shown in Figure 4. The effect becomes even more pronounced when an attempt is made to draw curved lines. However, this effect can be offset to some degree if the picture elements (*pixels*) adjacent to the line are turned on at a lower intensity. This procedure, known as *anti-aliasing*, is shown in Figure 5.

Hard copy is probably the least advanced area of computer graphics.

The vector system and the raster system are each well suited to a particular kind of environment. The vector system is excellent for drawing diagrams or modeling. The raster system is much better at displaying fully rendered, or continuous-tone images, such as pictures. If one tried to draw a photograph by specifying straight lines of different colors, the picture would probably degenerate into dots anyway.

Memory requirements

Since the phosphor of a CRT (except for storage types) has a short persistence, the entire image must be refreshed at least 30 times per second from data held in memory located either in the display device or in the host computer. How much memory do we need? Since vector devices require a starting point and an end point for each line on the screen, the storage required at a given moment may vary from two 2-byte integers for a single line to many thousands of 2-byte integers for a complex figure. A raster device, on the other hand, requires sufficient memory to define the state of every possible pixel on the screen. For the high-resolution display of 1280 x 1024, we would need 1.3 million bits of information to light up every point on the screen in one color. For three colors, we would need 3.9 million bits; this would give us seven combinations of the primary colors, but if we want intermediate shades, we shall have to have several bits of color information at each pixel position; 8 bits for each color would give 256 shades of that color, and a total of 16 million possible colors. Even though there are methods for economizing on memory requirements, a raster-based color display is obviously a glutton for memory!

Frame buffer logic

Figure 6 shows how the bits in the memory are converted into varying voltages that drive the color tube. The data for one *frame* are held in a memory buffer called the frame buffer. A frame is one pass over the screen, so that in a non-interlaced display with approximately 240 lines in the raster, the complete image is built up from a single frame. In an interlaced display, with about 480 lines, two frames are re-

Continued from page 45

quired; the first draws the odd raster lines (1, 3, 5...etc.) and the second draws the even raster lines (2, 4, 6...etc.). Interlacing reduces the flicker that would otherwise occur because of the long vertical retrace time.

For each pixel, the appropriate bits are read from the frame buffer; these are converted by digital/analog converters into the voltages that cause the beam to make the pixel bright or not so bright.

The amount of information that a signal can deliver to a device in a computer system in a given time is called the data transfer rate. In an analog broadcast system this is called the bandwidth. In order to draw a moving picture, we have to fill up the frame buffer with new information from the computer 30 times per second, just as a TV set does. To do this, we have to deliver 120 megabytes per second to the device—160 times more than a TV set can deliver. This would be equivalent to 160 broadcast channels all used to serve one display. We see, therefore, that from a technological point of view, the *transmission* of the data presents far more of a problem than actually *displaying* it does. With current technologies, it is not possible to update this display in real time. The fastest data transfer rates available use data streaming channels at rates approaching 6 megabytes/sec; the normal access rate for terminals using alphanumeric data is 1200 bits/sec, or 120 bytes/sec; at this rate, the high-resolution display of 1280 x 1024 pixels would take almost five hours to fill. Clearly, we need some other way of filling the frame buffer.

Compression techniques

There are two ways of reducing the amount of data that we need to transmit to a display device. In most moving pictures, some objects stay in the same position for a number of frames, and therefore we do not need to retransmit the data defining them. If we can restrict the data sent to information about *changes* in the picture, we can substantially reduce the transmission time needed.

In most pictures, a significant part of the image will be taken up by colors of the same intensity, including unfilled or black areas; thus, for each raster line we can define the number of contiguous pixels having the same color, instead of defining every pixel separately. This technique is known as *run length encoding.*

Figure 7 shows how the data stream required for transmission can be reduced by run length encoding. In the example, the black border is specified as 300 pixels long, then the bars as red and green (200 pixels each), and the other border as 600 pixels. This method reduces the data stream and the required storage by a factor of several hundred.

TV encoding

Three methods of TV encoding are used in the world today. The PAL system, used in western Europe, gives the best picture, yielding about 20% better horizontal resolution and 20% more lines than the American system.

The SECAM system, developed in France, closely follows the PAL system for image clarity.

Finally comes the NTSC system used in the USA. Although this was developed first, it ranks last for resolution and color stability—NTSC is often corrupted to stand for "Never Twice the Same Color"! The amount of data, and thus the resolution, of a TV display CRT is limited by the 6-MHz bandwidth specified by the NTSC standard.

In most pictures a significant part of the image will be taken by colors of the same intensity.

CRT developments

What kind of increase in resolution can we expect in TV development?

The development of HDTV (High Definition TV) is progressing, though slowly. I have already mentioned a display device that has a resolution of 1280 x 1024—the Raster Technologies Model 1/80. One of the main problems in producing it is in the manufacture of the shadow mask—remembering that there are three holes for each display point, we realize that the mask must have almost four million holes in it. The flowers shown in Figure 8 give some idea of the quality of this type of display unit.

The principal problem being faced by development facilities is that of compatibility. If some newer technology is used for HDTV, then the system will probably be incompatible with present TV receivers. If the system developed is compatible with existing TV receivers, then the new units will be more expensive because they require costly decoding electronics.

Several HDTV systems are in the prototype stage, both in the USA and in Japan, but we can expect only a very slow entry into the consumer market with these systems. RCA spent six years trying to become profitable with color TV, and many companies will wait to see whether acceptance of the system will provide economic returns before they enter the fray.

The question of standards must also be considered when deciding whether to develop new systems. There have been battles in many areas between competing technologies, notably over the TV encoding scheme and Beta vs. VHS. Now a new battle over floppy disks for use in personal computers is starting: 3", 3.25", and 3.5" diskette drives are all available, and there is not yet much evidence to indicate which (if any) will become dominant as a de facto standard.

Advances are much more likely in the use of digital TV. The analog signal will be digitally encoded by the receiver, and the digital image may then be stored in memory and manipulated just as the frame buffer is. Features such as still frame, zoom, and color correction based upon lookup table manipulation all become possible with these developments.

With the increasing use of video recorders in the consumer market and the recent explosion in personal computer sales, the market is, I think, awaiting the introduction of low-cost video editing equipment, which will provide the effects commonly seen on commercial TV. Already, consumer cameras have limited video effects built in.

Most future TVs will have the ability to interface directly to personal computers. Currently, PCs must either use a separate RGB monitor, or else encode their images onto an RF carrier in order to display computer-based images on a standard color TV set. This encoding, together with the narrow bandwidth of the RF stages, loses much of the quality actually available in the PC. However, a TV set with RGB input would allow this encoding stage to be bypassed, so that a single unit could serve both for normal TV broadcast reception and to display higher-resolution images from computer-based images transmitted in digital form. Sears

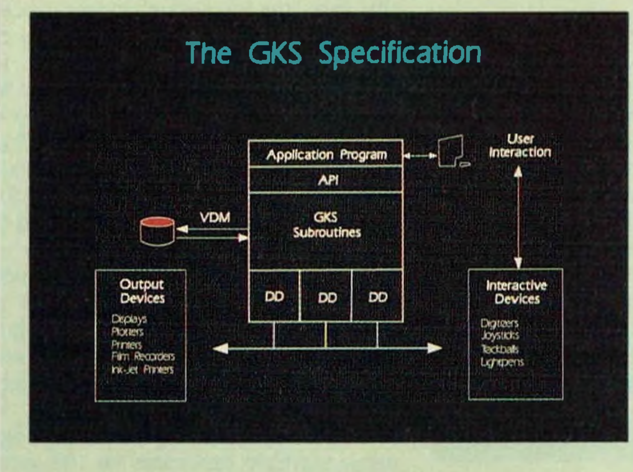

Figure 9. *Block diagram of the GKS interfaces.*

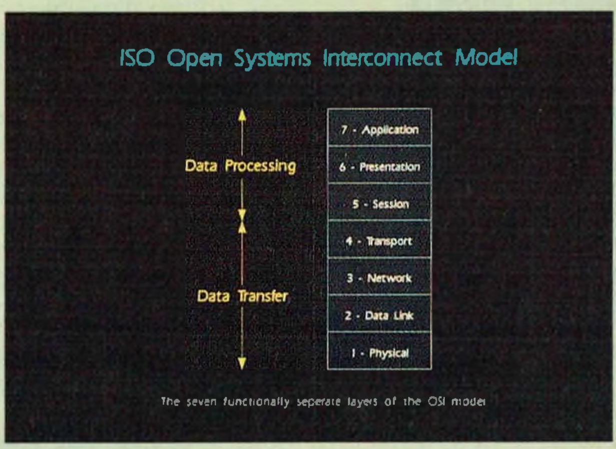

Figure 10. *The seven layers of the ISO model.*

recently announced that they will market such a unit.

The CRT on which current display devices are based suffers, however, from numerous physical disadvantages—size, weight, high voltages and power consumption, expensive components, and fragility. Other technologies may bring more convenient and cost-efficient developments in the future.

New display technologies

IBM, last year, announced the development of a high-resolution display terminal called the LICD, or Large Information Content Display. This device was based on liquid crystal technology and had a display surface one meter square; the resolution was 8000 x 8000—a total display capacity of 64 million pixels. IBM set up an IBU (Independent Business Unit) to market the display, but recently cancelled the project. Although IBM gives no official reason for the cancellation, the LICD was generally considered to be too advanced for its time.

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GRAPHICS

Continued from page 47

Work still in progress at IBM includes a completely new type of display: the Electrochrominance Display Device (ECDD). The technology is based on that used in semiconductor chip fabrication.

The heart of the semiconductor chip is a silicon wafer about 0.25" square. Fabrication of these is done on an array plate, a circular plate about 3" in diameter containing 300 such wafers. Each 0.25" wafer can contain many thousands of transistors, which are the base unit of the logic circuitry in all semiconductor devices. When fabrication of the transistors is complete, the array plate is cut into individual wafers, which are then bonded into a plastic shell that gives the characteristic look of a silicon chip.

The principle of the electrochrominance display is to use the transistor nodes as plating sites for a compound of about 20 different chemicals called viologen. This is a translucent purple solution that is plated onto the receptor cells in direct proportion to the amount of current passed through the cell. Thus, continuous-tone images may be built up by plating each cell for a different time period.

Each cell can be plated separately, and the deposit of viologen remains after the plating current has been removed. The deposit may be removed by passing current through the cell in the reverse direction. It takes only a few milliseconds to complete the plating process for the whole display, and the persistence of the image eliminates the need for the costly memory of a frame buffer for image refreshing.

This technology yields 96,000 pixels on a wafer 1" square—an incredibly high resolution. Optical systems are used to magnify the image up to any size desired. An obvious drawback, at the moment, is that only one color (a purplish-gray) is available.

This technology is, of course, in its infancy, and there are many hurdles to be overcome before a device using this technology could become commercially available.

Film

Although a display device is useful for an interactive environment, most people still want some form of permanent record. Hard copy is probably the least advanced of all areas in computer graphics; it is produced in a number of forms that in general fall into one of two groups: film output and printed output. I do not class TV tape and motion picture film as hard copy, since these cannot be viewed by a passive device such as a slide viewer.

Color photography has its roots in James Maxwell's famous experiment of 1861. He used an additive technique, by which three separate slides were exposed, each filtered by one of the primary colors. Three projectors, equipped with the same filters (one each), were used to superimpose the three colored images on a screen for viewing. Additive systems are today used in display devices and in any situation where multiple-color light sources are combined on a screen. Although additive film systems have been neglected for the past 50-60 years, the new Polachrome film by Polaroid uses the RGB additive system.

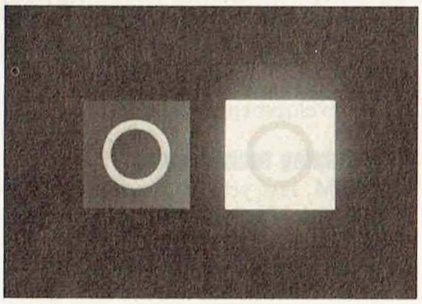

Figure 11. *Effect of background intensity on apparent brightness.*

Subtractive systems represent the majority of color processes in use today for both film and print media. The subtractive primaries are dyes that absorb the red, green, and blue portions of the composite wavelengths, thereby subtracting the corresponding color from pure white light. The three color layers in subtractive films each act as filters to record the resultant color of the scene.

35mm film recorders vary in price from $1500 for a Polaroid Palette system to over $350,000 for a Celco CFR4000; they are used to make 35mm images that can be used separately as slides or combined to create movies. The Celco CFR4000, for example, was used by Disney in the making of TRON. Very-high-resolution recorders, such as the Dicomed D48, can achieve 16,000 pixels horizontally. The resolution of a 35mm slide is about 3,600 x 2,400 pixels, so for 70mm film or color plates the recorder must be capable of even higher resolution.

There are two ways of obtaining a film image from a computer display. One way is to supply the RGB signals to a color monitor inside the film recorder; the display is then photographed through the built-in 35mm camera. In this case, the resolution cannot exceed that of the monitor, and a direct copy of the image will be seen on the slide. In fact, a standard 35mm camera can be used to photograph a normal display in a dark room, and will be equally effective (though perhaps less convenient). I would suggest that you use 400 ASA film, and an exposure of 1/8 second at f5.6.

The other technique, which can achieve much higher resolution, is to separate the three color images using a digital interface. The red, green, and blue images are passed in turn to a high-resolution monochrome monitor. A 35mm camera then records the image using multiple exposures on the same frame and a color wheel carrying red, green, and blue filters. As each color is laid down, it interacts with the color underneath it to produce the desired image. Thus the image itself is manipulated digitally, in three color segments, just as the video signal was manipulated in the digital interface.

35mm film is the standard used in commercial image processing for computer graphics. The resolution of 3600 x 2400 makes it a suitable medium for computer-generated images as well as for film and printing.

There is a whole range of other output devices, though none of them has the quality associated with film. These other devices include pen plotters with eight pens, and the Xerox 6500. The 6500 is a photoconductor-based device that works on a photocopier principle and produces 8-color copies at the rate of three per minute.

Plotters

Pen plotters, while able to draw vector outputs, have only eight pens and are too slow for most commercial environments. The popular press likes the image of a businessman printing charts on his plotter; in reality, I suggest that the length of time it takes a professional person to produce useful output negates the benefit of most plotters for business graphics.

As technology increases the resolution of display devices and decreases their cost and size, the display panel will become an ever more important tool in our lives. The use of film for print will remain the basic output medium, though lower costs and higher resolution will be available for film-based devices.

Printers

In the realm of hard copy, commercial printing still provides the best quality for the best price. However, the faithfulness of color reproduction is a vague concept when applied to printing. It is not unusual for an art director to instruct printers to "add some glow," "cool it down," or "give the reds a bump." These terms communicate emotions; it is the printer's job to turn these emotions into a physical state despite all the obstacles placed in his way by the nature of the process.

The basic function of paper is to reflect light. The other functions are to enable the ink to adhere to the surface and have the right properties for good drying.

The smoothness of the paper is one of the most important properties in determining correct color reproduction. Smoothness is obtained by sizing, which decreases the porosity and absorbency of the paper; and calendaring, which polishes the surface under high pressure.

The print process of lithography normally uses the half-tone printing method, in which the images are converted into dots of various size. Since a press cannot print nuances of tone or color, but only solid areas, all colored illustrations are converted into dots. In general, a four-color process is used. When you add the three subtractive primary colors together you should get black; in practice, you get a brownish color, so black is also used, just to help the theory along.

The inks used by printers contain oils, pigments, and driers. The various pigments all contribute to variations in the way light passes through the compounds, and thus of the perceived final color. In some cases, light hitting the paper is absorbed, rather than reflected, or is diffracted away from the observer into the paper. It may also be deflected by ink particles.

And finally, the color of a printed image depends greatly on the color of the viewing light—just as people turn strange colors when seen by the light of sodium-vapor street lights. Because of all these variables, the output of graphics onto paper is possibly the least exact science of all those encountered in image processing.

Ink-jet printers use the subtractive color technique, and spray ink at the paper through the tiny holes of a dot matrix head. The ink is ejected by piezoelectric pumps, one at a time. The inks combine on the paper to form seven colors from the three primary colors: magenta, cyan and yellow.

Although ink-jet printing is generally of a lower quality than photo-offset, and is used only as a management information tool, ink-jet technology is being refined. I can see 1984 as a year of increasing proliferation of ink-jet devices.

Image creation

Let us now turn to the actual creation of images. The landscape in Figure 1 was generated solely by software. Each item in it was created separately by a mathematical model. The mountain was created by a technique called fractalization. The wooden posts were created as smooth blocks, after which a surface texture was mapped onto them. The road was created as a solid polygon and then fractalized, after which the surface color was mapped onto it. The flowers were created by using mathematical models of growth, from nothing but equations.

Several important techniques were used here. A ray-tracing procedure is used to determine a pixel's color and luminance. The value of a point on the surface of an object depends upon the effects of hidden surfaces, reflection from other surfaces, their colors, shadows, and the depth of shadow, refractions through transparent images, and the texture of light-reflecting surfaces. Although the process of ray-tracing

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CIRCLE 5 ON READER SERVICE CARD

GRAPHICS

Continued from page 49

produces quite astounding effects of realism, the algorithms use astronomical amounts of computing power to develop the pictures—the image shown here (in Figure 1) took over 40 hours on a Cray-1 supercomputer to generate. Roughly the first half of the movie TRON was rendered through ray-tracing techniques.

The mathematics are really quite simple, involving only simple geometry to find the point where a ray, traced from the eye of the observer until it strikes an object, intersects a light ray coincident with the light source(s). At this point, the ray is traced again until it hits another object. The level of depth to which tracing is taken varies. It is generally considered that six levels of depth provide the most effective realism and coloring for objects.

The time requirements are large because of the recursive reentry into a program loop that is required by the tracing algorithms. As an example, it could take over 6 trillion calculations to make a one-minute movie with a scene containing only one thousand objects.

Although this is a fantastic-looking picture when one understands the process used to create it, showing it to the average person would probably still elicit the comment that the scene does not look real.

Standards

There are two organizations in the world that control the commercial development of graphics standards: the ISO (International Standards Organization) and ANSI (American National Standards Institute).

The ANSI committe is composed of a number of groups that consist of representatives of corporations with a vested interest in the creation of a framework for product development. An ANSI committee designated X3H3, chartered in 1979, consists of four task groups representing 60 companies and organizations, and is actively developing a family of graphics standards. The only official standards in the U.S. are those being developed by task groups that are part of the ANSI X3H3 committee.

The first standard, the Graphics Kernel Standard (GKS), is a functional specification of a graphics application programming interface standard. It provides device-independent input and output capabilities and was initially developed by DIN, the German standards institute. This standard was refined by ISO and X3H3. It is important to realize that this standard will take effect only if complete approval from task group members is received. Majorities are not accepted in the standards committees; unanimous agreement must be reached.

Figure 9 shows the framework of the GKS system. It provides programmers with a set of defined subroutines that may be used for the interactive drawing and manipulation of graphics objects. This is achieved by using a Cartesian coodinate system, and executing a number of subroutine calls that will draw lines, shade segments with color and, at a higher level, define symbols and allow them to be moved around.

The main point of the GKS standard is that it provides a set of clearly defined procedures that make graphics applications portable between systems that adhere to the GKS standard.

The GKS standard is a *functional* specification. As such, it does not describe how it should appear to any specific language environment. To customize the GKS interface, it must be "bound" to a particular language. In the case of Fortran, for example, this involves specifying the names of the subroutine calls that correspond to the various GKS functions, as well as the required variables and their types. In the USA, this work is done by X3H3; in ISO, a separate group has been estab-

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lished to deal with language bindings. In addition to Fortan, both groups are now working on subroutine-like bindings of GKS to Pascal, C, Ada, and PL/I. These bindings will be included in Part 2 of the ANSI standard.

VDM

Another standard, which is now out on a four-month review, is the Virtual Device Metafile (VDM) standard. The goal of this standard is to provide storage and/or interchange of graphics images. This standard is important, as it will allow vastly differing systems to communicate with one another graphically.

NAPLPS

The North American Presentation Level Protocol Syntax (NAPLPS) standard was developed independently of the X3H3 committee. The term *Presentation Level Protocol* is derived from a model defined by ISO. This model is an assembly of interrelated protocols required to define an entire communications system. The layered system architecture allows an "open system connection," or data exchange, between participating systems. SNA is an example of a system that conforms to this standard.

(Editor's note: For a more detailed description of the ISO model, refer to Part 1 of William G. Wong's article "Introduction to Local Area Networks," published in the October 1983 issue of Microsystems.*)*

Figure 10 shows the seven layers of the ISO model. Layer 6, the Presentation Layer, is what we are concerned with here. PLP, the Presentation Level Protocol, provides the means to represent and interpret the information in a data encoding format that preserves its meaning. The application layer is the highest layer in the reference model, and these protocols define the service actually desired by the end user. As an example, the informations retrieval service commands of a videotex application form part of the application layer protocol.

To understand the implications of NAPLPS a little better, it is important here to say a little about videotex, the environment in which NAPLPS is currently most widely used. First, we should define some terms. The term *teletext* is commonly used to refer to a unidirectional broadcast television *teletex* service. *Teletex* (without the last 't') is a term officially adopted by CCITT to define a specific type of terminal-to-terminal text communications service. The term *videotex* describes a bidirectional data transfer protocol that is specifically designed for the display of alphanumeric and picture data.

The videotex standard concentrates on a precise data stream definition, primarily for output representation on raster-based devices. It may be thought of as a standard in which the output should be representative of information, rather than an exact replica of the transmission. It is acceptable, therefore, for a device to be classed as a videotex receiver even though it may not support the full capability of the protocol. Deficiencies that may not affect the representation of data include such features as blinking or the ability to select the full range of colors.

A teletext service continually transmits a sequence of frames, each of which consists of a page of information. Pages are composed of alphanumeric text and pictures, described by PDIs (Picture Description Instructions). A PDI is a special instruction that causes an action to take place; for example, line, rectangle, polygon, and circle are PDIs. The receiver consists of a decoder that converts the RF frequencies to a data stream consisting of header information (which may include the page number), a selection table, and the alphanumeric text and PDIs that make up the screen image.

The consumer using the service makes a choice from a menu by pressing

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GRAPHICS

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a button on a remote, hand-held unit. This response is translated internally by the receiver into an absolute page number. The receiver then scans the incoming data stream, searching for a header with the appropriate page number. The service is thus delivered as a hierarchy of menus through which the user may browse. Certain special functions on the hand-held unit may take the user directly to a preset menu—the index page, for example.

Videotex, on the other hand, is an on-demand service for communication with a computer center via a telephone line. The receiver performs the same basic functions as the teletext decoder, but the communications line allows interactive services to be provided; these may include banking, the ordering of goods, and so on.

NAPLPS is not designed as a very high-resolution system. Most receivers will be TV sets with limited bandwidth. For a number of reasons, the coordinate structure was chosen to be 256 x 200: the coordinate can be transmitted in one byte, thereby reducing transmission time; the TV receiver cannot display resolutions much higher than this; and 256 x 200 allows the use of the 0.78 aspect ratio found on all present TV receivers.

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The NAPLPS standard does, however, have provision for 3D perspective. In most systems, the technology has not yet reached a state that would allow a 3D system at a low enough cost, but the feature is included for the sake of standardization at a future date.

The success of videotex systems will depend largely upon the cost of the decoder associated with PLP translation; this cost may be as high as $1000, though commercially available home units may become available for as little as $300. The personal computer may provide one answer to this problem. Several devices now commercially available for PCs can retrieve and display PLP syntax. Possibly the best of these is an add-on board from Micropixel, in Ontario. This is a full NAPLPS decoder, called Quickpel, available for the IBM PC and clones, for less than $700. It is capable of displaying the full PLP syntax, including textures, color mapping, mosaics, and supplemental characters, and can also run telesoftware in the on-board 8088 microprocessor that does the decoding. It is important to realize that telesoftware has to be written exclusively for such a system, as telesoftware does not exist within the ANSI standard.

New systems in experimental stages are using cable systems to distribute the videotex service. This requires the use of addressable cable decoders and a high level of security to prevent unauthorized access to information. Security is the main drawback at the moment, and must be solved before a useful two-way service can safely be conducted via cable.

Consider, for example, that the information for all homes on the same cable must flow into all households, and that only one household will be correctly addressed by the data stream. Should the security system be penetrated by anyone, that person could have access to confidential information concerning bank accounts, trust funds, or worse yet, electronic funds transfer systems. The detection of a penetration device would be almost impossible until after fraudulent action had taken place—and even then the device might not be discovered.

Encoding methods do exist, and those such as MA-Com's Videocypher1 and Videocypher2 are currently being tested by various companies involved in confidential data communications using satellite links. ◼

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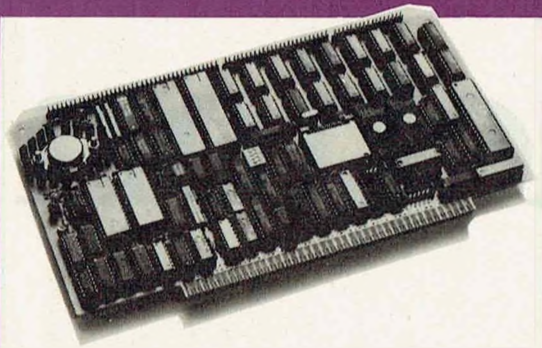

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An Introduction to NAPLPS

A programmer's approach to NAPLPS, with a hands-on example

by David McCune

Micros are hermaphroditic. Leave one alone in a darkened office for a day or two and—voilà!—where there was one, there are now two. And soon four and eight, and then they have spread to all the branch offices. The various species combine and mutate and struggle for predominance. Eventually, every desk has its own database, display and disk format. Decentralization has been accomplished.

The resulting electronic cacophony puts special demands on today's system integrators. First, data communication is at a premium. Data must constantly be transferred and translated. Communication protocols, such as the X.25 standard described last month (*Microsystems*, June 1984), are more important than ever.

Moving data is only part of the problem. It must also be displayed. In terms of the "layered architecture model" described last month, data communication occurs in layers one to five, while display is handled in the sixth layer—i.e., the presentation layer. (The seventh layer—the application layer—deals with the commands used by the end-user to manipulate the data communicated and displayed via the lower-level protocols.)

All presentation of data on CRTs or printers uses graphics. We tend not to think of a lowercase "a" as a graphic, but in fact it is just as much a graphic as a circle or rectangle. So far, the only presentation level standard for graphics display that has won wide acceptance on micros is the small subset of graphics that make up English alphanumerics, i.e., the American Standard Code for Information Interchange. The ASCII Presentation Level Protocol specifies, for example, that a computer's display software should produce a graphic form recognizable as a lowercase "a" whenever it encounters a byte with its bits set to 61h. If you want to encode a red "a" or a blue circle, though, the ASCII standard is useless.

As memory prices drop and CRT controllers improve, sophisticated graphic displays become increasingly important tools to end users. In the absence of a graphics presentation level standard, though, each applications programmer and computer manufacturer is free—indeed, is almost compelled—to encode and interpret graphics in a unique way.

Much gnashing of teeth could be

avoided if a clear, flexible, extensible, hardware-independent graphics standard existed. In fact, the following graphics encoding schemes have been suggested as standards: GKS (Graphical Kernel System), CGL (Core Graphics Language), VDM (Virtual Device Metafile), and NAPLPS (the North American Presentation Level Protocol Syntax).

A standard, like a prophet, gains its power only from the faith and number of its believers. Which of the three encoding schemes will emerge as a true standard will be determined largely by the marketplace, rather than by semi-official bodies like the American National Standards Institute. The NAPLPS scheme has been adopted by some heavy hitters in the marketplace—most notably, AT&T—though it is still far from being a true standard. The purpose here is not to proselytize for NAPLPS, but simply to describe it and point out some of its strengths and weaknesses.

Most of NAPLPS' advocates are in the videotex business. We can define videotex loosely as communication of graphic information from central host databases to remote terminals via various communications media, such as phone lines, television signals, FM subcarriers and so on. This videotex orientation is a key to understanding NAPLPS' power as well as its limitations.

The most valuable resource in data communications is bandwidth, which limits the number of bits that can be transmitted per second. Since videotex is by definition heavily reliant on data communications, it is only natural that any videotex graphics communication standard would place a premium on compact encoding of graphic information. Indeed, NAPLPS' ability to store and transmit extremely compact graphics in relatively few bytes is one of its strengths. We will see examples of this efficiency when we examine a sample NAPLPS frame (Listing 1).

Compact graphics encoding is useful to a videotex system operator only if display hardware and software exists in quantity. Preferably, existing hardware from various vendors should be adaptable (via software graphics interpreters) to NAPLPS. The standard should be extensible, i.e., it should not become obsolete as hardware with higher pixel and color resolution becomes available. And the standard's framework should be able to encompass future marketplace demands, e.g., for integrated sound capabilities or downloaded applications software. NAPLPS is relatively device independent and extensible.

(*A note on terminology:* The process of reading NAPLPS-encoded bytes and translating them into color graphics is sometimes called "decoding." The word "decoder" in this article does not necessarily refer to special, external hardware. We use the word in a more abstract sense to mean a conceptual black box which consists of I/O channels that are linked by a software or firmware interpreter. Some NAPLPS decoders now on the market are indeed standalone physical devices, but a decoder may also consist of an existing microcomputer's I/O channels, e.g., a disk drive or RS-232 port for input and a video board for output, linked by NAPLPS interpretation software supplied by a third-party vendor. Such interpretation software can transform, say, a standard IBM PC into a NAPLPS decoder capable of displaying NAPLPS graphics stored on a local floppy disk or retrieved from CompuServe or Viewtron.)

A standard, like a prophet, gains its power only from the faith and number of its believers.

The key to understanding NAPLPS is its organization. NAPLPS was designed to work in either a 7-bit communications environment or, slightly more efficiently, in an 8-bit environment. The number of possible NAPLPS graphics commands far exceeds the 128 possible combinations of binary digits in a 7-bit word. Even the 256 possible 8-bit codes are insufficient. The solution is a scheme—not specific to NAPLPS—called "code extension."

(Though NAPLPS defines both 7- and 8-bit encoding schemes and uses slightly different code extension techniques for each scheme, all examples in this article will come from the more common 7-bit environment. Most current videotex systems operate over voice-grade phone lines with simple asynchronous 7-bit transmission. But as synchronous, error-correcting data networks—e.g., the Local Area Data Transport network provided by Southern Bell and used by the Viewtron NAPLPS database in Florida—become more common, 8-bit NAPLPS will likely increase in popularity.)

NAPLPS organizes the 128 7-bit codes into a traditional table consisting of 8 vertical columns and 16 horizontal rows (Figure 1). Any slot in the table is identified by its column and row, which, when presented in hexadecimal format, form a number in the range 00h to 7Fh. Thus the slot identified as 5/14 (column 5, row 14) is slot 5Eh.

The current NAPLPS standard defines nearly 600 different graphics codes. The technique used to map these codes into the 128 available 7-bit slots is illustrated in Figure 2. (This illustration is from the official NAPLPS spec, which you can get for $20 plus $4 handling from the *American National Standards Institute, Sales Department, 1430 Broadway, New York, NY 10018.* The complete NAPLPS spec is document X3.110. You must have this document if you plan to do any serious NAPLPS work.)

The basic idea is that the hundreds of codes are organized into groups, according to function. All of the codes used to draw the standard ASCII characters from 20h to 7Eh, for example, are grouped together, as are those codes used to draw more complex graphics such as circles. Six different groups are used to draw graphics; these groups make up the "G-set repertoire." In addition, NAPLPS defines two groups of 32 codes, each of which control miscellaneous display and communications attributes; these are the "C-set" repertoire.

The process of selecting a specific code from the G-set repertoire takes two steps. First, one of the possible sets must be placed into one of the four "on-line" G-set areas. This is accomplished with one of the escape sequences shown in Figure 2. (Note that in its start-up state, the four G-set areas are already filled with default groups from the repertoire.) Next, one of the four G sets is invoked into the "in-use" table, i.e., it is mapped into rows 2 through 7 of the 7-bit table. This invocation into the in-use table is accomplished when the interpreting software receives one of 6 control codes from column zero or one of the in-use table (the C0 set).

The important point here is that NAPLPS allows for extension of the number of sets in the G-set repertoire. This repertoire now contains the following sets:

Primary character set. The ASCII characters between 21h and 7Eh. By default, this set occupies the G0 set. (And since G0 is the default set in the in-use table, it follows that a NAPLPS interpreter at startup will interpret any character in the range 21h to 7Eh as an

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ASCII character. Any other interpretation would require invocation of another G set into the in-use table.)

Supplementary character set. Includes special characters such as fractions, arrows, and various letters specific to European languages. This set occupies the G2 set by default.

PDI (Picture Description Instruction) set. Contains commands for drawing geometric primitives (e.g., "arc" or "rectangle"), specifying color, coordinates and so on. Occupies the G1 set by default.

Mosaic set. Contains 65 2 x 3 block mosaic character cells which can be used to draw rather blocky graphics. (This set may seem unnecessary in addition to the PDI graphics set, and indeed, it was included in NAPLPS largely to insure compatibility with a previous would-be graphics standard used in the British Prestel videotex system. ANSI is a political, as well as technical, organization. . . .) Though I have only seen it used by one videotex system operator, the mosaic set is the default G3 set.

Macro set. As we shall see later, any valid string of NAPLPS code can define a macro and can be assigned a name in the range 20h to 7Fh. Once defined and transmitted to the NAPLPS interpreter, the macro will be executed any time the macro set is invoked into the in-use table and the macro name is transmitted.

DRCS (Dynamically Redefinable Character Set). The patterns which form the ASCII and Supplementary character cells are permanently stored in the NAPLPS decoder. But the user can define customized patterns for up to 96 different character cells in the range 20h to 7Fh. Like a macro, the dynamically redefined character is executed when the DRCS is invoked into the in-use table and a character code is transmitted.

The NAPLPS code extension technique allows for orderly additions to the G-set repertoire. Indeed, a number of such additions repeatedly crop up in discussions among NAPLPS aficionados. A G set for sound, defining the frequency and duration of various sounds, tops many NAPLPS wish-lists. (This poses a fascinating metaphysical question: can sound be thought of as graphics? Both sounds and light, after all, may be described in terms of how human sense organs—eyes or ears—are excited by physical media which oscillate at various frequencies.) Other possible G sets include phonemes (for speech synthesis), or even full implementation of a programming language (in which the language's various instructions would be mapped into a G set) to facilitate downloading of "telesoftware" along with graphics information.

The C0 control set maps to columns zero and one of the 7-bit table. Some of its codes, e.g., 0Ah (linefeed), are interpreted as you might expect (the cursor is moved down one line). Others, such as 19h, have NAPLPS-specific interpretations (shift G2 set into in-use table in non-locking manner). Still others, such as 06h (ACK), are used by lower protocol layers for transmission control. The C0 set is always in the low two columns of the in-use table and can never be redesignated by another set from the C-set repertoire.

The heart of NAPLPS consists of the graphics codes available in the PDI set.

The C1 control set, when invoked, occupies columns 4 and 5 of the in-use table. It contains a potpourri of graphics and control characters, such as "define macro" and "cursor off." (Indeed, the inclusion of clearly graphic codes such as "set text to double height" in a so-called control set leads to unnecessary confusion.)

This overview of NAPLPS' organization should trigger one astonishing insight: the graphic protocol which we commonly refer to as the ASCII character set is a true subset of NAPLPS. In the NAPLPS context, the common 80 x 25 monochrome ASCII display consists entirely of the primary character set, some C0 codes and appropriate color and character size codes from the PDI set. The ASCII character set is simply a part of a larger graphics repertoire available to the NAPLPS programmer.

NAPLPS's heart, of course, consists of the graphics codes available in the Picture Description Instruction (PDI) set. The PDI concept is simple and powerful; it provides a means of describing (and transmitting) complex graphics with relatively few bytes.

The relationship between PDIs and their resultant physical display is similar to that between a high-level programming language and the machine code that ultimately runs on a computer. At its least abstract level, a computer graphics display is produced by instructions (in the form of one or more bits) that tell the video circuitry how to illuminate each logical phosphor dot (pixel) on the screen. (This is true for common raster-scan graphics displays; the much more expensive and rarer vector graphics systems use a different technique.) Obviously, any increase in the number of logical dots on the screen (resolution) or in the number of possible states of illumination (color) requires a greater number of bits in video display memory and so increases the cost of the display hardware.

One simple-minded and highly inefficient means of storing and transmitting graphic information would be to record the bit settings for each pixel on a screen. A computer might read this information and set each bit accordingly in its video memory. There are two serious problems with this idea. First, even a relatively simple graphic requires large amounts of storage space and, subsequently, transmission time. (As an example, a medium-resolution color graphics screen from the IBM PC stored this way—using, say, BASIC's BSAVE statement—requires 320 x 200 x 2 bits, or 16K bytes.) Second, the organization of video memory is at the very soul of a computer, and manufacturers have used many different schemes. As owners of some quasi-IBM-compatible PCs have discovered, a dump of video memory from one machine may produce garbage when loaded into another machine's video RAM. In spite of its limitations, this "memory dump" approach has one advantage: the software required to "decode" a graphic is cheap and simple. The programmer merely needs to move bits from the graphic file into the proper locations in video RAM and—bingo!—an image appears.

The PDI concept, on the other hand, is analogous to high-level programming languages. (The word *analogous* is important here; as we shall see, NAPLPS does not yet supply the basic necessities of a true programming language—e.g., conditionals or loop structures.) Much of NAPLPS code consists of high-level PDI statements such as RECTANGLE, followed by coordinate data. The PDI opcodes and operands are highly abstract and must be translated by a NAPLPS interpreter into the low-level bit settings read by the video circuitry (Figures 1 and 3). The interpreter insulates our high-level graphics commands from the low-level requirements of our specific display hardware. In so doing, we gain many of the same advantages offered by a high-

Figure 1.
NAPLPS 7-bit in-use table.

				b8	1	1	1		1		1	1	1	1
					8	9	10		11		12	13	14	15
				b7	0	0	0		0		1	1	1	1
				b6	0	0	1		1		0	0	1	1
				b5	0	1	0		1		0	1	0	1
b4	b3	b2	b1	COLUMN ROW	0	1	2		3		4	5	6	7
0	0	0	0	0	▨	▨	RESET	CONTROL	RECT (OUTLINED)	RECTANGLE	NUMERIC DATA			
0	0	0	1	1	▨	▨	DOMAIN		RECT (FILLED)					
0	0	1	0	2	▨	▨	TEXT		SET & RECT (OUTLINED)					
0	0	1	1	3	▨	▨	TEXTURE		SET & RECT (FILLED)					
0	1	0	0	4	▨	▨	POINT SET (ABS)	POINT	POLY (OUTLINED)	POLYGON				
0	1	0	1	5	▨	▨	POINT SET (REL)		POLY (FILLED)					
0	1	1	0	6	▨	▨	POINT (ABS)		SET & POLY (OUTLINED)					
0	1	1	1	7	▨	▨	POINT (REL)		SET & POLY (FILLED)					
1	0	0	0	8	▨	▨	LINE (ABS)	LINE	FIELD	INCREMENTAL				
1	0	0	1	9	▨	▨	LINE (REL)		INCR POINT					
1	0	1	0	10	▨	▨	SET & LINE (ABS)		INCR LINE					
1	0	1	1	11	▨	▨	SET & LINE (REL)		INCR POLY (FILLED)					
1	1	0	0	12	▨	▨	ARC (OUTLINED)	ARC	SET COLOUR	CONTROL				
1	1	0	1	13	▨	▨	ARC (FILLED)		WAIT					
1	1	1	0	14	▨	▨	SET & ARC (OUTLINED)		SELECT COLOUR					
1	1	1	1	15	▨	▨	SET & ARC (FILLED)		BLINK					

▨ **C0 set (NAPLPS control characters)**
☐ **PDI G set, with graphic primitives in columns 2–3 and numeric data in columns 4–7**

level programming language—hardware independence, portability of code, compactness. We also incur some disadvantages: by placing the onus of decoding graphics instructions in the local terminal, we increase the necessary complexity and expense of that hardware. And as is true of any interpreter, NAPLPS decoders tend to be relatively slow. Indeed, NAPLPS users who are used to high-speed memory-mapped graphics displays often complain that NAPLPS screens build too slowly. (As far as I know, all NAPLPS decoding software to date has been based on the interpreter concept. This is probably a reflection of NAPLPS' videotex roots, where graphics are transmitted as serial data and displayed immediately as they are received. We can conceive, though, of a NAPLPS "compiler." As an example, we could download NAPLPS code to an IBM PC disk for later compilation into BSAVE-type memory images. When moved into video RAM, these images would display much faster than if they had been processed by a NAPLPS interpreter. Such a compiler is clearly unsuitable for videotex or for displaying animated NAPLPS, but other uses spring to mind.)

Armed with our understanding of basic NAPLPS concepts, we should be able to trace our way byte-by-byte through a NAPLPS picture. Listing 1 is a disassembled, commented listing of the NAPLPS code used to draw the simple flowers in Figure 1. (Luckily, I have no artistic ambitions. See Figure 2 for examples of what more qualified NAPLPS artists can produce.) Note that the listing is merely a pedagogical tool; the actual NAPLPS file consists solely of the bytes represented in the "Hex" column. And the description of this file does not pretend to be exhaustive; many NAPLPS features will only be touched upon and some will not be mentioned at all. You must use the complete NAPLPS specification to understand and create NAPLPS accurately.

During the course of decoding a frame, a NAPLPS interpreter may set a host of graphics attributes such as color, text size, line width, etc. When the bytes of a particular frame are sent to the decoder, it is often wise to reset some of these attributes to a default state. As an example, if one frame sets a thick line width, then all subsequent lines drawn will be thick, even those in subsequent frames, unless the line thickness is reset at some point.

The first 10 bytes of Listing 1 perform reset functions. Byte 1 (18h) is from the C0 set and is used to cancel currently executing macros. Macros, as we shall see, are named strings of arbitrary NAPLPS code which execute when their names are invoked. Since NAPLPS allows nested and even recursive macros (used for some interesting animation effects), it is possible to leave a decoder in an infinite macro loop. The 18h terminates such loops and allows the decoder to go on to subsequent bytes.

Byte 2—1Bh from the C0 set—is a shift code. It puts the C1 set into columns 4 and 5 of the in-use table. Since this shift code is non-locking, the C1 set will only remain in use for the one subsequent character. 45h from the C1 set

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terminates all current macro, DRCS and texture definitions. This is a useful safety feature that should be included at the start of any new frame. As an example, suppose a frame includes a macro definition. During a normal macro definition, received code is buffered in the macro memory and not displayed until called. A macro definition usually ends with a 45h from the C1 set, or the beginning of a new macro, DRCS or texture definition. But suppose that due to a communications error the frame is truncated. The decoder will be left in the "Define Macro" state, and all subsequent NAPLPS code—including new frames—would be buffered in the macro memory and not displayed. The 45h from C1 near the top of the frame avoids the problem.

The next byte executes a "non-selective reset," a quick way to put the G- and C-sets back into their default states (Figure 2), as well as to reset text attributes, line width, color mode, texture selection and operand format (see below). The non-selective reset may be followed by bytes in the 40h to 7Fh range, where bits 1 to 6 are interpreted as the row/column cursor position. (Note that NAPLPS numbers the bits in a byte from 1 to 8 rather than from 0 to 7, as is traditional in data processing. We will follow the NAPLPS convention here.) Since we will specify cursor positioning explicitly later in the frame, we drop those 2 bytes here.

Byte 5 locks the G1 set into the in-use table, where it will stay until explicitly replaced by another G set. Since the PDI set is the default G1 set, and since the previous non-selective reset restored all G sets to their default states, we now have the PDI set in columns 2 to 7 of the in-use table.

Byte 6, therefore, is interpreted as a PDI reset. Like all PDIs, this one takes the form "opcode, operand 1 . . . operand n." PDI opcodes always come from columns 2 or 3 of the PDI table; the operands are always from columns 3 to 7. (Note that this makes operands easy to recognize: if bit 7 is set, then the byte must be an operand. In fact, this is one of the keys to how extensibility is accomplished, as we shall see when we examine the "set color" operand below. If a decoder has lower resolution than the number of operands provides, it can simply ignore the subsequent operands until the next opcode byte.) The bits of the two reset operands are used to initialize various attributes, such as the macro and DRCS tables, the color palette, and to clear the display screen. By setting bits 1 to 6 of both operands to 1, we perform a total reset.

Definition of color is probably the single most exciting part of NAPLPS. Besides the graphic power provided by NAPLPS' handling of color, the color encoding technique highlights two of the standard's most important features: hardware independence and extensibility.

Before going on with NAPLPS, we need some background in color techniques for computer graphics. In most raster-scan graphics systems (the type used on nearly all micros), each logical pixel of the display is represented by 1 or more bits of video RAM. If only 1 bit is allotted to a pixel, of course, then that pixel can be set to only two states (binary 1 and 0), i.e., illuminated or dark. The result is a monochrome display. If, though, each pixel is given 2 bits of video RAM, then each pixel can be set to one of four different states. Some systems even allocate 3, 4 or even more bits to each pixel. (The number of bits set aside for each pixel in the display is referred to as the depth of the bit plane. Thus the medium-resolution graphics display on the IBM PC is sometimes referred to as a 320 x 200 x 2-bit display; its bit plane is 2 pixels deep.)

While nearly all raster-scan graphics systems use this same concept of single- or multiple-bit planes, they fall into two basic groups, depending on how the bits allocated to each pixel are interpreted by the video circuitry. In the most common and least expensive case, each possible combination of bits on the z-axis of the bit plane is associated with one combination of the red, green and blue electron guns on the display monitor. Thus, in a 2-bit-deep bit plane, 00b might mean that all guns are off (black), 01b might turn just the red gun on, 10b might turn the green gun on, and 11

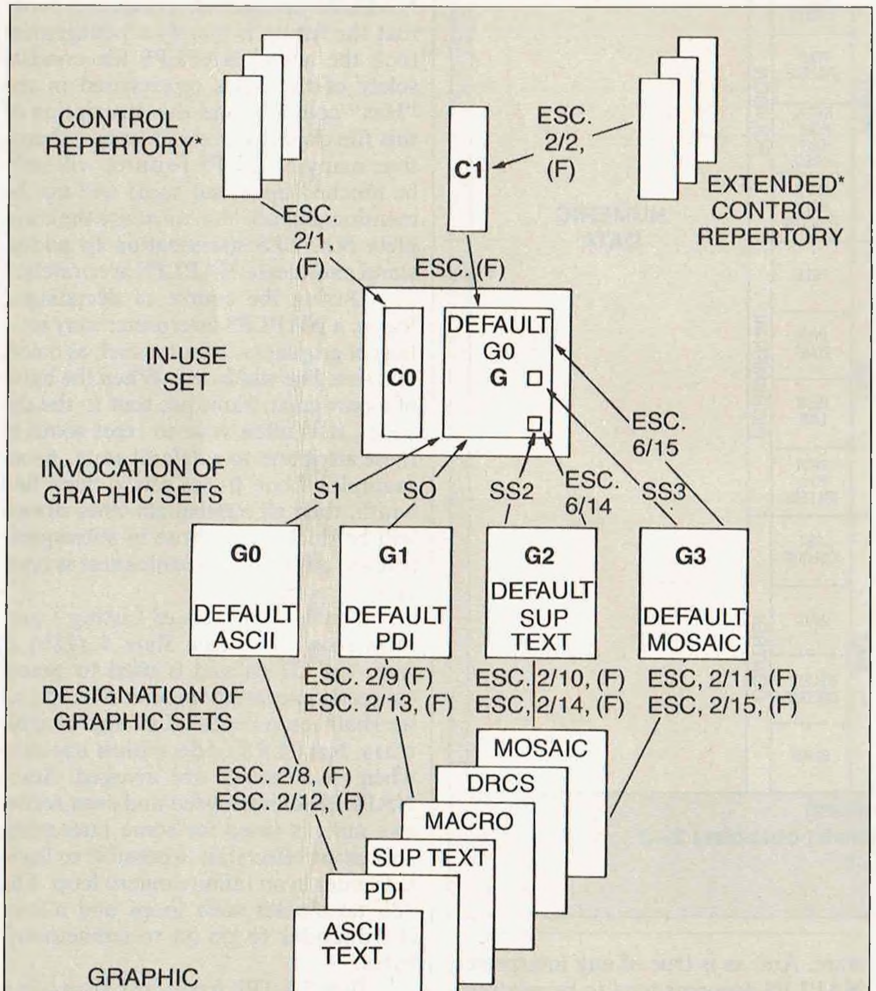

Figure 2. Code Extension in a 7-Bit Environment.

might turn on the blue gun. If the bit plane is 3 bits deep, for example, the combination 110b might turn on the red and green guns simultaneously, producing a yellow pixel. The point here is that in this technique, the state of the bits in the bit plane directly controls the state of the electron guns in the display monitor. The number of different colors which can be displayed is limited by the amount (and expense) of video RAM, and the displayable colors are fixed by the video circuitry. Note here that if we draw a red rectangle, and then want to change it to blue, we must modify at least 2 bits in video RAM for every pixel of the rectangle.

The second, more sophisticated technique is called color mapping. Here, the z-axis bits in video RAM do not directly control the electron guns. Rather, these bits are interpreted as true binary numbers. Each number is an index into a table which in turn contains bits controlling the intensity of the red, green and blue guns. As an example, assume a 320 x 200 x 3 video display. The three bits on the z-axis can represent eight different numbers (0 to 7). Suppose we also set aside 48 bits of RAM, split into eight sections of 6 bits each. We can number the sections 0 to 7. We now have a 48-bit table with eight entries, each of which can correspond to one of the eight possible numbers represented by the 3 bits on our bit plane's z-axis. We further split each of our 6-bit entries in the 48-bit table into three sections of 2 bits. Each 2-bit section controls the intensity of one of the red, green or blue electron guns in our monitor.

The creation of a color display is now a two-step process. First, the video logic must read the bits associated with a particular pixel. Next, it must use these bits as an index into the 48-bit color table. Once it finds the proper entry in the table, it must analyze the 6 bits for that entry and set the red, green and blue gun levels accordingly.

The video circuitry for the color-mapped display is relatively complex, to be sure, but consider the flexibility we have gained. First, while our 3-bit bit plane still only allows us to display eight simultaneous colors, each color is defined by 6 bits in the 48-bit color table. Thus, we can choose our eight simultaneous colors from a range of 64 possible colors. And with the addition of a mere 24 bits to the color table, we can offer 9 bits in each entry, i.e., each slot in the table can represent one of 512 different colors. A further and even more striking advantage arises if we consider changing our red rectangle to blue. Now, instead of modifying many bits in video RAM, we need modify only the one 6-bit entry in our 48-bit table that defines the color red. When we modify this entry, every pixel that points to it will instantly change color. These lightning color switches can be used for blinking and animation.

OPCODE	b8	b7 b6 FLAG	b5 b4 b3 DESCRIPTOR FIELD	b2 0	b2 1	b1 0 (FACILITY FIELD)	b1 1 (FACILITY FIELD)
CONTROL	X	01	000				
POINT	X	01	001	INVIS	VIS	ABS	REL
LINE	X	01	010	JOIN	SET	ABS	REL
ARC	X	01	011	JOIN	SET	OUTLINE	FILL
RECTANGLE	X	01	100	JOIN	SET	OUTLINE	FILL
POLYGON	X	01	101	JOIN	SET	OUTLINE	FILL
INCREMENTAL	X	01	110				
CONTROL	X	01	111				

INVIS = **Invisible**
VIS = **Visible**
JOIN = **Start from current drawing pt.**
ABS = **Absolute**
REL = **Relative**
SET = **Set drawing pt. first**

Figure 3. Opcode facilities.

NAPLPS supports both mapped and non-mapped displays. Our sample NAPLPS file assumes color mapping. The process of defining the color of a map entry takes two steps: the slot must be specified by means of a "select color" opcode (3Eh, byte 11) and operand, and then the "set color" opcode is used to mix the color bits in the table entry.

The format of the set color operand illustrates NAPLPS' hardware independence and extensibility. One fundamental goal of NAPLPS is that the same graphics code should be valid on hardware of varying pixel and color resolutions. Bytes 14 to 16 serve as an example. This 3-byte operand enables us to specify 6 bits each of green, red and blue definition. (The 6 bits are interpreted as a fraction of full intensity for green, red or blue.) This operand format can thus support an 18-bit color table entry (256K different colors!). If this code is transmitted to a decoder that supports, say, only 3 bits each of green, red, and blue (512 different colors), the interpreter can simply truncate the least significant 3 bits of each color.

Conversely, if the code were to specify only 3 bits for each color to a decoder that had higher color resolution, the interpreter would merely tack enough zeros onto the end of each color definition to create a full high-resolution color definition. Remember that the interpreter has no trouble handling variable-length strings of operands; as we mentioned earlier, opcodes all have bit 6 set, while operands do not. Once it receives an opcode, the interpreter will treat all bytes as operand data until it receives a byte which has bit 6 set to 1. The point here is that NAPLPS interpreters may be written for hardware of widely varying sophistication, and the same NAPLPS code sent to these various interpreters will display in predictable, albeit different, ways.

The drawing in Figure C-10 (page 102) requires five different colors (defined in bytes 11 to 40). Note in bytes 36 to 38 that we can mix various intensities of green, red and blue to form essentially any color (in this case, a light reddish brown to be used for a flower pot.)

Having created a customized five-color palette, we are ready to draw. The first object will be a blue border around the edge of the screen. One way to do this is to draw an outlined rectangle around the edge of the display. The four-step procedure includes: (1) setting the "brush" size, (2) selecting a color slot for drawing, (3) setting the origin of the rectangle and (4) specifying the delta x and y coordinates of the rectangle's

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diagonally opposite coordinates.

The "Domain" opcode (byte 41) defines the "logical pel" size, i.e., the number of physical pixels which will be covered by a single NAPLPS point or line. The logical pel can be as small as a single pixel (the default) or as large as the entire screen. Its most common use is to draw "hefty" objects, e.g., thick-edged arcs or rectangles.

Besides being used to specify the logical pel, the domain opcode has another important function: it controls the number of bits that will make up subsequent coordinate, color and color-map definitions. NAPLPS' elegant method for defining coordinate data can serve as an illustration.

In order to ensure hardware independence, NAPLPS does not define coordinate data in terms of pixel locations on the display. After all, a NAPLPS frame should display correctly on a 256 x 200 pixel screen as well as on a 512 x 400 or 1024 x 800 screen. NAPLPS coordinate data are given in terms of fractions of a 1 x 1 "unit screen." This unit screen is an imaginary square onto which we map the actual physical display area of any particular monitor. Because most monitors are wider than they are high, the display's x-axis is usually 1.0 of the unit screen, while the y-axis is 0.75 of the unit screen. The origin of the unit screen is the lower left corner, and any location on the screen may be specified in terms of a fractions of each of the axes. Thus, the upper right corner of most monitors is at coordinate 1.0,0.75 on the unit screen.

NAPLPS encodes coordinate data in one or more bytes, as in Figure 4. Each byte contains two triplets of coordinate data, one for the x-axis and one for the y-axis. Higher resolution is defined by increasing the number of 3-bit triplets that are concatenated to form the complete coordinate. In the default case, for example, NAPLPS uses 3 bytes (i.e., three 3-bit triplets for each of the x- and y-axes) for coordinates. The 9 bits available for each axis are interpreted as a signed fraction of the unit screen. The 9-bit combination 001001101b, for example, is interpreted as 77/256; if this were an x coordinate, it would refer to a point slightly more than 1/4 the distance from the left side of the screen.

The interesting point here is that the number 77/256 is independent of the number of actual physical pixels in the physical display. This fraction is just as meaningful on a 320 x 200 display as on a 256 x 200 display. If the physical resolution increases beyond 256 pixels on either axis, of course, then we may want to increase the precision of our fraction (by increasing the number of bits we use for coordinate data). The domain opcode can be used to set the length of coordinate opcodes anywhere in the range 1 to 8 bytes. (Eight bytes gives us 23 bits of precision on each axis, far superior to any physical resolution likely in the forseeable future!)

As we intimated earlier, color data is also hardware independent; the bits for each color in each of the operand's bytes are concatenated and interpreted as an unsigned fraction of full brightness for a particular color (Figure 5).

The advantage to using this fractional system of coordinate and color definition is that NAPLPS code which uses, say, 3 bytes for coordinate data (8 bits of precision per axis) will produce a reasonable display on monitors with both higher and lower resolutions. The interpreter running on the specific hardware need only append or truncate the appropriate number of bits to the coordinate and color data to produce a fraction of the necessary precision.

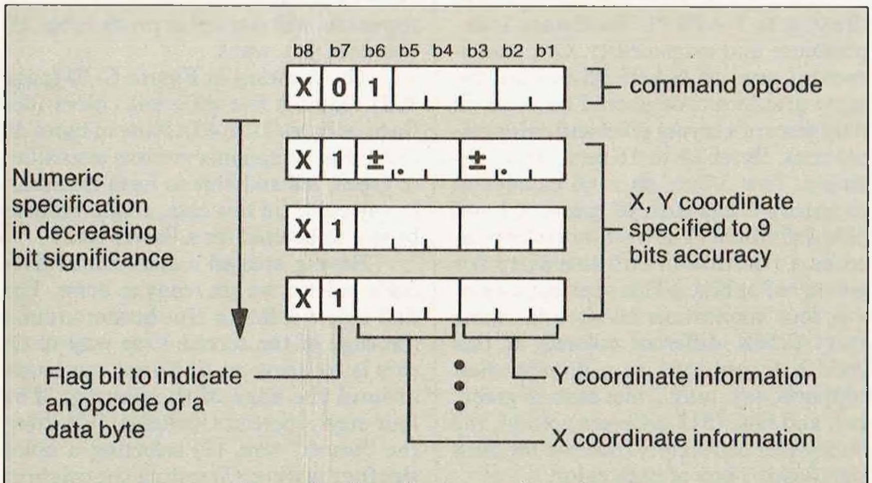

b8 b7 b6 b5 b4 b3 b2 b1
X 0 1
command opcode
X 1 ± . ± .
X 1
X 1
Numeric specification in decreasing bit significance
X, Y coordinate specified to 9 bits accuracy
Flag bit to indicate an opcode or a data byte
Y coordinate information
X coordinate information

Figure 4. Coordinate encoding scheme.

In our sample drawing, the byte immediately following the domain opcode specifies the length of subsequent opcodes for coordinate and color data. (We leave these values at the defaults.) The next 3 bytes are coordinate data which specify the x and y dimensions of the logical pel (setting them to 5/256 and 5/200, respectively).

Since our rectangle should be blue, and since we earlier set color-map slot 2 to blue, we must now select slot 2 as the current drawing color (bytes 46-47).

NAPLPS offers five so-called "graphic primitives": point, line, arc, rectangle and polygon (Figures 1 and 3). Each primitive is basically encoded as an opcode followed by coordinate data. The coordinate data may be either absolute or relative, i.e., coordinates may refer to an absolute location on the display or to movement relative to previous coordinates. The primitives are defined by setting and moving an imaginary "drawing point" around the screen.

We start our rectangle by locating the invisible drawing point to the lower left of the screen (bytes 48-51). We next send a rectangle opcode, followed by 3 bytes of coordinate data. The interpreter will locate one corner of the rectangle at the current drawing point. It will then move the drawing point away from this initial corner by the x and y distances specified in the 3-byte operand. These two points will be connected by a rectangle.

Bytes 56 to 74 should be clear. The logical pel is reset to 1/256 x 1/256 of the unit screen, a new small blue rectangle (solid, not outlined) is drawn, the drawing point is set to a location inside this small rectangle, and color-map slot 3 (yellow, for now) is chosen.

The next bytes will put the words "FLOWER IN POT" on the screen, in the current color, beginning at the current drawing point. Since we currently have the G1 set (which now contains the PDI set) in the in-use table (remember the 0Eh at byte 7), we need to shift the G0 set back into the in-use table (byte 75). We then write some text and switch the G1 set back into the in-use table (bytes 76-88 and byte 89).

A note about writing text via NAPLPS is in order. It is possible to specify many more text attributes than merely location and color. A special opcode—"Text"—can be used to determine the direction of the character path (right, left, up or down), the orientation of the individual character cells around the z-axis, the amount of space between characters and between lines, and the x and y dimensions of the character cell. Since our drawing called for values equal to the defaults—including a character cell size of 1/20 x 6/256—we had no need for the "Text" opcode.

From the perspective of standardization, text is one of the more troublesome features of NAPLPS. The problem is due to the facts that (a) NAPLPS does not define a character font and (b) NAPLPS permits proportional spacing of text but does not define the algorithm to be used for this spacing. It is perfectly "legal," then, for one decoder manufacturer to design a font in which the "i" or "l" is one pixel wide, while another vendor designs a font in which these characters are two pixels wide. Further, since the actual implementation of proportional spacing is up to the vendor, it can happen (and it does!) that one decoder might fit, say, 43 proportionally spaced characters on one line, while another allows only 42. Lines can break in different places on different decoders! This problem plagues some videotex system operators who use NAPLPS interpreters supplied by different vendors.

The rest of our sample drawing will consist of two identical flowers in two identical flowerpots. The flowers will be made from a brown polygon (the pot), a thick green line (the stem), a white hatched circle (the outer petals), and a solid yellow circle (the center of the flower). In order to make two of these flowers appear, it would be possible to simply draw the four objects twice, each time specifying different drawing points. We can be much more efficient, though, if we use NAPLPS' macro capability.

NAPLPS allows us to give any arbitrary string of valid code a name in the range 20h to 7Fh. Once such a macro string has been transmitted to the interpreter, the actual string of code will be executed any time its name is invoked from the macro set.

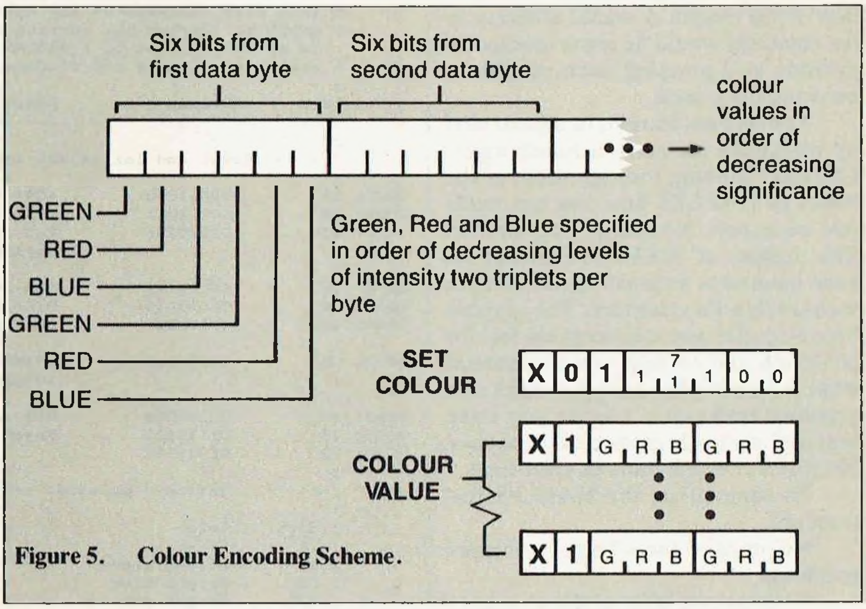

Six bits from first data byte
Six bits from second data byte
colour values in order of decreasing significance
GREEN
RED
BLUE
GREEN
RED
BLUE
Green, Red and Blue specified in order of decreasing levels of intensity two triplets per byte
SET COLOUR
X 0 1 1 1 1 1 0 0
7
COLOUR VALUE
X 1 G R B G R B
X 1 G R B G R B

Figure 5. Colour Encoding Scheme.

In our example, we begin by shifting the C1 set into columns 4 and 5 of the in-use table (byte 90) and sending a "Define Macro" opcode followed by the name of the macro to be defined. Note that we chose our name from the high end of the range (7Fh). NAPLPS does not specify how macro names are to be assigned, but a de facto standard has evolved. Some decoder manufacturers —AT&T, most importantly—have used the NAPLPS "Transmit Macro" feature. A transmit macro is a macro which, when executed, is not displayed on the user's screen but is transmitted back to the videotex host computer. AT&T's Sceptre NAPLPS decoder includes eight programmable function keys; a function key simply executes one of eight transmit macros. Since the eight AT&T function keys are permanently tied to macro names 20h to 27h, and since transmit macros share the same set of names as regular macros, it is important that any transmit macro definitions sent to the decoder at the start of a videotex session not be overwritten by other regular macros.

The graphics protocol that we refer to as the ASCII character set is a true subset of NAPLPS.

Once we have chosen a macro name, all following code—up to an "End" opcode or the beginning of a new macro, DRCS or customized texture definition—will be included as part of the macro and will be stored in the macro buffer. This buffer area is shared with DRCS and texture definitions; NAPLPS suggests that it contain at least 3K bytes. (This is not really enough memory if we consider how macros are ideally used. In common videotex systems, data transmission is very slow, so often-repeated templates, logos and other graphics are commonly encoded as macros and then downloaded to the interpreter at the start of a videotex session. If a full DRCS is defined along with a large set of complex macros, the system operator can easily run out of macro memory.)

The only noteworthy feature of our simple macro is its total lack of absolute drawing points. All coordinate data—including the very first coordinates in the first polygon (bytes 96-98)—are of the relative form. Thus there is nothing in our macro to tie it to any particular screen location. The location of the entire four-element drawing will be determined by the location of the last drawing point to be defined just before the macro is executed. In bytes 147 to 164, we see that the macro is executed twice, and that an absolute drawing point is specified prior to each execution.

The second execution of the macro required 5 bytes. Those bytes replaced 51 bytes. This type of savings, when multiplied by hundreds or thousands of frames in a NAPLPS database, can be very important.

The macro feature also points up another of NAPLPS' deficiencies. Before we execute a macro, we have no way of saving the state of various attributes, such as drawing color, palette definitions, character size and so on. If a macro modifies any of these attributes, we have no way of restoring them to their pre-macro values upon termina-

Intro to NAPLPS

Continued from page 61

tion of the macro. A useful addition to the standard would be some method of pushing and popping such attributes onto and off a stack.

You will not learn to be a great chef by watching me cook a hamburger. Likewise, running through some of the basics of NAPLPS here has not made you an expert NAPLPS programmer. The number of NAPLPS features we have ignored is as great as the number we have thus far examined. The purpose here is to give you a conceptual feel for NAPLPS and to help you understand what it does well and what it lacks as a graphics technique. I hope you have learned enough to decide whether NAPLPS is worth more of your time.

To summarize, the NAPLPS features are:

- Compact encoding of complex graphics;
- Hardware independence due to high level of abstraction;
- Extensibility.

In spite of its supporters' hype, though, NAPLPS is not the ideal graphics standard, even if it is arguably the best game in town for now. We have already mentioned some of its deficiencies, such as its lack of a stack structure, lack of conditional and loop structures, and its unstandardized text fonts and proportional spacing algorithm.

Other serious problems stand in NAPLPS' way as well. Most worrisome from the perspective of the graphics programmer, NAPLPS provides no method for storing portions of the bitmap for later restoration. There is, then, no way to perform truly nondestructive drawing. Whenever we draw a new object on a frame, anything "under" that object is gone forever. Given this lack of bit-map access, along with the slowness of any NAPLPS interpreter, the only way to do high-speed animation from NAPLPS is via kludgy color-map manipulations such as blinks. This restriction alone is enough to condemn NAPLPS in the eyes of many CAD/CAM programmers.

Even in the videotex environment NAPLPS has other weaknesses. For example, NAPLPS bills itself as a "presentation level" protocol and very firmly avoids any mention of other levels in the layered architecture model, particularly the session and application levels. Examples of nonstandard session level commands facing videotex operators are escape sequences to switch local terminals from high-resolution monochrome mode (for ASCII-based presentation) to lower-resolution color mode (for graphics presentation), or escape commands to cause transmitted code to be written to the local terminal's disk. Each videotex system operator is now free to develop a unique set of session level commands.

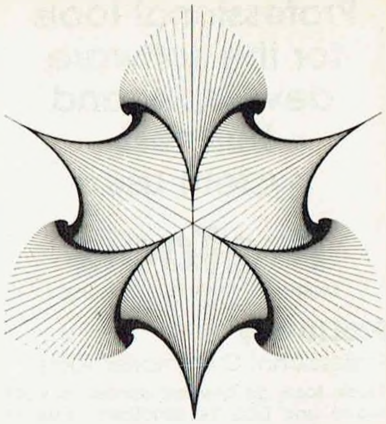
Another problem facing decoder manufacturers (or interpreter writers) is the growing confusion concerning how to deal with user input to NAPLPS videotex services. NAPLPS provides for "unprotected fields," for example, in which the user can enter NAPLPS code from his local terminal. These entries can be as simple as a bank account number or as complex as a signature. But NAPLPS leaves the definition of the local keyboard commands necessary to do this local editing to the application level, i.e., to the terminal or interpreter manufacturer. Unfortunately, though, the videotex operator has to provide standardized help screens and user guides which describe these local editing commands, even though the end users own a variety of terminals.

Even if one argues—correctly, I think—that the application and session levels are properly left outside NAPLPS' domain, these problems provide an interesting insight. A true graphics standard must be more than a mere presentation level standard. NAPLPS may be a useful guideline for the system integrator, but given the lack of session and application level standards to accompany NAPLPS, it is not a complete graphics solution.

```
      ; This file illustrates the NAPLPS code required to draw a simple
      ; graphic.  If the hex numbers in the "HEX" column are translated
      ; to bytes and sent to a NAPLPS decoder, the decoder will draw a
      ; simple picture of two flowers in flower pots.
      ;
      ;Hex      Binary           Description
      ;---      --------         -----------
      ;
      ;------ Reset and initialize NAPLPS interpreter: ---------------
      ;
0001: 18      00011000         <CAN> - cancel executing macros
0002: 1B      00011011         <ESC> - non-locking shift into C1 set
0003: 45      01000101         End all ongoing macro, DRCS, texture
      ;                        definitions
      ;
0004: 1F      00011111         Non-selective reset
0005: 40      01000000         Bits 1-6 of these 2 operands determine cursor
0006: 40      01000000         position (0,0 in this case)
      ;
0007: 0E      00001110         Shift out.  Put G1 (default = PDI) set into
      ;                        in-use table
      ;
0008: 20      00100000         PDI reset
0009: 7F      01111111         Reset everything
0010: 7F      01111111
      ;
      ;------   Define a palette: ------------------------------
      ;
      ; Slot    Color
      ; ----    -----
      ; 01      bright green
      ; 02      bright blue
      ; 03      bright yellow
      ; 04      white
      ; 05      brown
      ;
0011: 3E      00111110         Select color    (Assuming a 16-entry color
0012: 44      01000100         Color slot 1    map, 4 bits needed to
      ;                                        define slot #.  These bits
      ;                                        are left-justified, with
      ;                                        bit 6 the msb.)
      ;
0013: 3C      00111100         Set color
0014: 64      01100100         green = 111111  (operand format = 01grbgrb
0015: 64      01100100         red   = 000000                    01grbgrb
0016: 64      01100100         blue  = 000000                    01grbgrb)
      ;
0017: 3E      00111110         Select color
0018: 48      01001000         Color slot 2
      ;
0019: 3C      00111100         Set color
0020: 49      01001001         green = 000000
0021: 49      01001001         red   = 000000
0022: 49      01001001         blue  = 111111
0057: 48      01001000           angl-val opnd = 1 byte (b2 & b1 = 00)
0058: 40      01000000           mult-val opnd = 3 byte (b5 - b3 = 010)
0059: 40      01000000           logical pel = 1 x 1
0060: 49      01001001
      ;
      ;  Set point and draw blue rectangle at center top of screen
      ;
0061: 24      00100100         Point set, absolute invisible
0062: 4A      01001010         x = 001010101 (85/256d)
```

David McCune, Proteus Group, Inc., 195 Garfield Pl., Brooklyn, NY 11215

```
0063: 56        01010110        y = 010110000 (176/256d)
0064: 68        01101000
      ;
0065: 31        00110001        Rectangle, outlined
0066: 48        01001000        delta x = 001010110 (86/256d)
0067: 51        01010001        delta y = 000001110 (14/256d)
0068: 76        01110110
      ;
      ; Get ready to put some yellow text inside the small
      ; rectangle
      ;
0069: 24        00100100        Point set, absolute invisible
0070: 4A        01001010        x = 001011001 (89/256d)
0071: 5E        01011110        y = 010110010 (178/256d)
0072: 4A        01001010
      ;
0073: 3E        00111110        Select color
0074: 4C        01001100        Color slot 3
      ;
0075: 0F        00001111        Shift G0 (default = primary ASCII set)
      ;                         into in-use table
      ;
      ; Output a text string:
      ;
0076: 46        F
0077: 4C        L
0078: 4F        O
0079: 57        W
0080: 45        E
0081: 52        R
0082: 20
0083: 49        I
0084: 4E        N
0085: 20
0086: 50        P
0087: 4F        O
0088: 54        T
      ;
0089: 0E        00001110        Shift G1 (default = PDI) set back into
      ;                         in-use table
      ;
      ; When we draw the flower, do it within the envelope of a
      ; macro.  That way, we can draw a second flower very
      ; efficiently by merely invoking the macro.  Note that no
      ; absolute drawing points may be set inside such a macro.
      ; All drawing points will be relative to a start-point to
      ;
0023: 3E        00111110        Select color
0024: 4C        01001100        Color slot 3
      ;
0025: 3C        00111100        Set color
0026: 75        01110110        green = 111111
0027: 75        01110110        red   = 111111
0028: 75        01110110        blue  = 000000
      ;
0029: 3E        00111110        Select color
0030: 50        01010000        Color slot 4
      ;
0031: 3C        00111100        Set color
0032: 7F        01111111        green = 111111
0033: 7F        01111111        red   = 111111
0034: 7F        01111111        blue  = 111111
      ;
0035: 3E        00111110        Select color
0036: 54        01010100        Color slot 5
      ;
0037: 3C        00111100        Set color
0038: 50        01010000        green = 001001
0039: 60        01100000        red   = 100011
0040: 56        01010110        blue  = 000000
      ;
      ;------ Draw some graphics -------------------------------------
      ;
      ; Set the line width (logical pel) to 5 pixels:
      ;
0041: 21        00100001        Domain
0042: 48        01001000          angl-val opnd = 1 byte (b2 & b1 = 00)
0043: 40        01000000          mult-val opnd = 3 byte (b5 - b3 = 010)
0044: 40        01000000          logical pel = 5/256 x 5/256
0045: 6D        01101101
      ;
      ; Draw a blue rectangle around the edge of the screen.
      ; Since the logical pel is set to 5 x 5 pixels, the
      ; rectangle's edges will be thick.
      ;
0046: 3E        00111110        Select color
0047: 48        01001000        Color slot 02
      ;
0048: 24        00100100        Point set, absolute invisible
0049: 40        01000000        x = 000000000b (0/256d)
0050: 40        01000000        y = 000000000b (0/256d)
0051: 49        01000000
      ;
```



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Intro to NAPLPS

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```
0052: 30        00110000        Rectangle, outlined
0053: 5B        01011011        delta x = 011111010b (250/256d)
0054: 78        01111000        delta y = 011000010b (194/256d)
0055: 52        01010010
      ;
      ; Reset logical pel to 1 x 1 (i.e., thin line):
      ;
0056: 21        00100001        Domain

      ; be defined just before the macro is invoked.
      ;
      ; Shift C1 control set into in-use table and output macro
      ; opcode:
      ;
0090: 1B        00011011        <ESC>
0091: 40        01000000        Define macro
0092: 7F        01111111        Macro 7F
      ;
0093: 3E        00111110        Select color
0094: 54        01010100        Color slot 5
      ;
0095: 35        00110101        Polygon, filled relative
0096: 48        01001000        delta x = 001011000b (88/256d)
0097: 58        01011000        delta y = 000000000b (0/256d)
0098: 40        01000000
0099: 40        01000000        delta x = 000001100b (12/256d)
0100: 4E        01001110        delta y = 000110010b (50/256d)
0101: 62        01100010
0102: 70        01110000        delta x = 110001111b (-112/256d)
0103: 48        01001000        delta y = 000000000b (0/256d)
0104: 78        01111000
      ;
      ; Make the logical pel 3 pixels wide:
      ;
0105: 21        00100001        Domain
0106: 48        01001000          sngl-val opnd = 1 byte (b2 & b1 = 00)
0107: 40        01000000          mult-val opnd = 3 byte (b5 - b3 = 010)
0108: 40        01000000          logical pel = 3 x 3
0109: 5B        01011011
      ;
0110: 3E        00111110        Select color
0111: 44        01000100        Color slot 1
      ;
0112: 25        00100101        Set point, relative invisible
0113: 40        01000000        delta x = 000101101b (45/256d)
0114: 6E        01101110        delta y = 000110011b (51/256d)
0115: 6B        01101011
      ;
0116: 29        00101001        Line, relative
0117: 40        01000000        delta x = 000000000b (0/256d)
0118: 46        01000110        delta y = 000110010b (50/256d)
0119: 42        01000010
      ;
      ; Set the logical pel back to 1 (which was its value when
      ; we started this macro.)
      ;
0120: 21        00100001        Domain
0121: 48        01001000        sngl-val opnd = 1 byte (b2 & b1 = 00)
0122: 40        01000000        mult-val opnd = 3 byte (b5 - b3 = 010)
0123: 40        01000000        logical pel = 1 x 1
0124: 49        01001001
      ;
0125: 23        00100011        Texture
0126: 58        01011000        line texture solid (b2 & b1 = 00)
      ;                         highlight off (b3 = 0)
      ;                         texture pattern crosshatch (b6-b4 = 011)
      ;
0127: 3E        00111101        Select Color
0128: 50        01010000        Color slot 4
      ;
0129: 2D        00101101        Arc, filled
0130: 40        01000000        x = 000000000b (0/256d)
0131: 46        01000110        y = 000110010b (50/256d)
0132: 42        01000010
      ;
0133: 23        00100011        Texture
0134: 40        01000000        texture pattern solid (b6-b4 = 000)
      ;
0135: 25        00100101        Point, relative invisible
0136: 40        01000000        delta x = 000000000b (0/256d)
0137: 41        01000001        delta y = 000001010b (10/256d)
0138: 42        01000010
      ;
0139: 3E        00111110        Select color
0140: 4C        01001100        Color slot 3
      ;
0141: 2D        00101101        Arc, filled
0142: 40        01000000        x = 000000000b (0/256d)
0143: 43        01000011        y = 000011110b (30/256d)
0144: 46        01000110
      ;
```

```
0145: 1B         00011011         <ESC>
0146: 45         01000101         End macro definition
      ;
      ; Execute the macro once, after first setting the drawing
      ; point to the correct spot:
      ;
0147: 24         00100100         Set point, absolute invisible
0148: 40         01000000         x = 000010100b (20/256d)
0149: 51         01010001         y = 000001010b (10/256d)
0150: 62         01100010
      ;
0151: 1B         00011011         <ESC>
0152: 2A         00101010         Intermediate character for G2 set
0153: 7A         01111010         Final character to designate macro set
0154: 19         00001001         Single-shift 2 (G2 to in-use, non-lock)
0155: 7F         01111111         Macro name = 7F
      ;
      ; Reset drawing point and execute macro again:
      ;
0156: 24         00100100         Set point, absolute invisible
0157: 50         01010000         x = 010010100b (148/256d)
0158: 51         01010001         y = 000001010b (10/256d)
0159: 62         01100010
      ;
0160: 1B         00011011         <ESC>
0161: 2A         00101010         Intermediate character for G2 set
0162: 7A         01111010         Final character to designate macro set
0163: 19         00001001         Single-shift 2 (G2 to in-use, non-lock)
0164: 7F         01111111         Macro-name = 7F
      ;
0165: 0E         00001110         Since the macro we just executed ends with
      ;                           an ARC opcode which can have a variable
      ;                           number of operand bytes, we must tell the
      ;                           interpreter that the string of operands is
      ;                           finished.  We do this by sending any byte in
      ;                           which bit 7 is set to 0, i.e., an opcode byte.
      ;                           Shift Out (0Eh) is commonly used for this.
      ;                           If we don't do this, the decoder will never
      ;                           display the final arc, since it will forever
      ;                           wait for additional operands.
```

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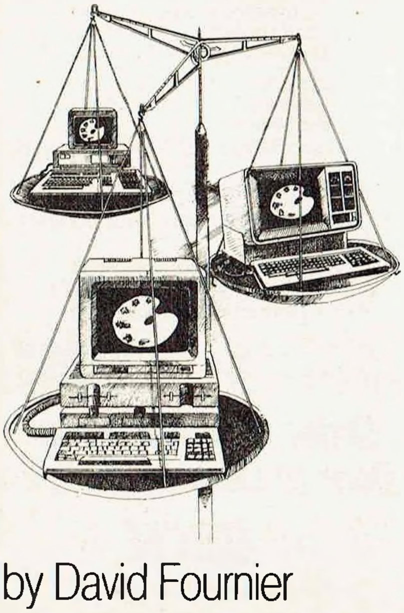
Graphics on the DEC PRO 350, NCR PC, and Mindset

Graphics and computing power on three notable systems



by David Fournier

In the last few years, advancing technology and falling prices in graphics hardware have spawned a whole new breed of microcomputer systems. These systems have immense graphic capabilities compared to previous generations, at little or no additional cost.

One interesting feature of this graphics explosion has been the lack of a single leader or standard emerging. Instead of the trend, becoming increasingly common in the last few years, of waiting for a single product to become successful and then copying it, there is a tendency for companies to come out with distinctly different products, at least in terms of their graphics capabilities.

These products fall into many unique families, each suited to individual market needs. In the graphics field in microcomputers today, it is possible for the systems integrator, OEM, purchasing agent, or small businessman each to choose the graphics system best suited to his needs. And with graphics standards beginning to take a foothold, the variety of graphics systems means even more flexibility.

For this article, we have chosen a representative system from each of three widely different families of products. Unfortunately, the newest of these systems, the Mindset, was not available in enough time for full evaluation.

Comparison of features

Table 2 presents a brief comparison of features among the three systems. Several of these features require further explanation.

Processing power

The division of processing power among specialized and general tasks represents a major difference in philosophy among the three systems.

The PRO 350 has all of its processor power devoted to general applications. Its powerful high-speed F11 processor chip set with hardware floating point—the same chip set used in the PDP-11/23, PDP-11/23+, PDP-11/24, and Micro/PDP-11—give it exceptional power for a microcomputer. However, it does not have as much hardware assist dedicated to graphics processing, with the exception of three LSIs on the basic video board (plus two additional LSIs with the extended bit-mapped option) for some fairly sophisticated pixel-level scrolling, both vertical and horizontal, and for pel-level (character-like) pattern repetitions. The result is a generally very high perfor-

Table 1. Benchmark times, interpreted and compiled (sec)

	NCR PC		DEC PRO 350		Mindset
Benchmark	Int.	Comp.	Int.	Comp.	Int.
Sieve of Eratosthenes	27.1	0.35	24.4	0.30	15.3
Circles	124	14	27	23	9.0
Quadrilaterals	265	1.0	25	20	5.8
Filled quadrilaterals	4450	83	62	57	102

mance system, but with lower graphics drawing speed for basic graphics primitives than other systems with greater hardware support.

The NCR Personal Computer (commonly known as the DecisionMate 5) represents almost the other extreme. Its Z80A and 8088 processors have the standard level of processor performance expected in personal computers today. But its graphics are controlled by the NEC 7220, a high-performance raster graphics controller. Consequently, its general performance is unexceptional, while its graphics performance, using only those functions provided by the 7220, is exceptional. Unfortunately, the instructions supported by the 7220 are somewhat limited, being unable to perform tasks such as filling objects (other than properly oriented rectangles), moving objects, drawing curves other than circular arcs, etc. Due to the high resolution of the NCR graphics display and the modest processor power, functions not provided by the 7220 are painfully slow if implemented in software.

The Mindset represents an attempt to achieve high levels of processor power in both general and graphics specific areas. The main processor is an Intel 80186, a fully 16-bit version of the popular 8088, with many integrated support chips. Also, it runs at a higher clock rate than most personal computer CPUs. Mindset claims a 30% speed advantage over more common personal computer configurations. In addition, the Mindset has two custom VLSI chips enhancing its graphics performance, as well as an additional frame buffer so that the processor can work on one frame while the VLSI chips are displaying another. The Mindset was clearly designed with graphics performance in mind.

Processing benchmarks

In order to aid comparisons of performance, several benchmarks were prepared. The results, shown in Table 1, deserve some explanation. Each benchmark was run twice on each system, once in interpreted Basic and once in a compiled language with graphics support (except for the Mindset, which was run in interpreted Basic only). The languages used were GW Basic and the MS Pascal compiler on the NCR and PRO/Basic and Pascal on the PRO 350. The graphics in the compiled version were done with NCR/Graph on the NCR and the Core Graphics Library on the PRO 350.

> **With graphics standards taking hold, the variety of graphics systems means more flexibility.**

The sieve of Eratosthenes benchmark determines the first 2500 prime integers. It involves extensive integer arithmetic, looping, array indexing, and other basic processor functions. As such, it demonstrates the basic speed of a variety of processor primitive operations.

The circle test consisted of drawing 126 circles of decreasing radii with their centers rotated around another imaginary circle so that they contained one common point, producing a Nautilus effect. As such, it has heavy floating-point computation (sine and cosine computations to determine the centers) plus simple graphics primitives. This is intended to simulate heavy calculations and graphics together, such as a CAD system.

The quadrilateral test is comprised of drawing 100 quadrilaterals. The four coordinates are chosen to lie at random points in each quadrant of the full screen. The test is run twice, once with the quadrilaterals merely outlined, and once filled. Computations are light, and the times are basically the drawing times of the primitives. This is intended to represent applications such as animation, which are primarily drawing-time related. Note that the fill algorithm for the compiled version on the NCR was written in software using the 7220 line drawing functions, as filling of random quadrilaterals was not supported by the 7220.

The results above clearly indicate that the general processor power of the PRO 350 is much the greater of the two evaluated. Although it does not execute the simple instructions used in the sieve benchmark much faster than the NCR, its richer instruction set allows much faster software graphic algorithms. This is clearly shown by comparing the interpreted quadrilateral benchmarks, which are performed entirely in software by both systems. The advantage of the hardware floating point is clearly demonstrated by the compiled circle test, where the PRO 350 competes well even though the NCR circle generation is done by hardware.

The quadrilateral benchmarks are of particular interest. The compiled unfilled version shows the vast advantage of the NCR in cases where computation is light and only 7220 functions are used. In the filled version, the compiled benchmark on the NCR was written using a software fill algorithm that used the 7220 line drawing function. Note that although this increased performance over the pure software algorithm by more than fiftyfold, the PRO 350 was still faster in pure software.

Note that the interpreted Basic programs on the NCR used software graphics algorithms, while the compiled routines on the NCR used the 7220 wherever possible. By contrast, the PRO 350 used its GIDIS software graphics driver for both interpreted and compiled programs. The time differences noted are mainly due to the comparison of interpretation versus compiled execution of the rest of the program, rather than differences in speed of graphics execution. Note also that the PRO 350 was doing considerably more work than the NCR, in that the plots on the PRO 350 were drawn in world coordinates, followed by clipping and scaling, whereas the NCR commands had to be specified directly in pixel coordinates.

Though the benchmarks were only partially available on the Mindset, the results indicate that it is somewhat higher than the NCR in general power, and similar to the 7220 in speed, but for

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a different set of primitives.

Overall, for graphics performance, the PRO 350 can be expected to be the most consistently powerful over a wide variety of graphics applications, while for more specialized applications, either the NCR or the Mindset may show higher performance.

Display characteristics

Text characteristics were similar on both systems reviewed, with color as the single exception. The NCR defaults to a green on black combination that is very easy on the eyes. The PRO 350, however, has a setup function to determine whether a monochrome or color monitor is attached. If set in monochrome mode with a color monitor, it also defaults to an easy green on black. However, it then will not show any color but green, even if color software is run. If color is to be displayed, the monitor must be set up as color, in which case its default colors are a glaring white on black, which is difficult to read in 80-column text, and very difficult in 132-column text. I was unable to find a way to change this, as even if different colors were set up via application software, they were continuously being reset at several points in the software, such as whenever an application returned control to the menus.

Graphics display characteristics are quite different among the three systems. The NCR has the highest resolution in color mode in terms of sheer number of pixels. While the PRO350 is close, its rather unusual distribution of pixel resolution, with four times as many pixels horizontally as vertically (which translates to an actual aspect ratio of 2½-to-1, since it is an 8 x 5, and not a square, viewport), makes it appear lower in resolution in certain cases. Circles, for example, look rounder and smoother on the NCR than on the PRO 350, although circles on the PRO 350 are still far better than those on the average microcomputer, such as the IBM PC. The extra horizontal resolution on the PRO 350, however, is what allows it to reasonably display 132-column text. The Mindset has much lower resolution, at least in color, although its monochrome resolution is as high as the others. This, however, can be better if what is desired is speed over resolution, such as for animation.

There are significant differences in color performance as well. The NCR has only eight fixed colors, which removes it from useful entry into several markets where the artistic flexibility allowed by color mixing is important. The Mindset, with 16 colors selectable out of a palette of 512, represents the other extreme. This allows it to be used to create far more esthetically pleasing pictures. In addition, color mapping can be used to great advantage in creating pseudo-animation. It represents one of the very few microcomputer products which meet the minimum color display requirements for the NAPLPS videotex and teletext standards. This means that, with appropriate software, it could properly display the frames residing on most videotex systems. It is an excellent candidate for use as a videotex terminal.

The PRO 350 is between the others in the area of color. It does have a color palette like the Mindset, which is unusual in microcomputer graphics, but only eight colors simultaneously out of a palette of 256. This allows similarly pleasing color selections to those on the Mindset. Where the Mindset allows eight levels each of red, blue, and green

Table 2. A comparison of three new graphics systems

Feature	NCR PC	DEC PRO 350	Mindset
CPU	Z80S @ 4 MHz (8088 @ 5 MHz optional)	Fil (PDP 11/23)	80186 @ 6 MHz
Graphics coprocessor	NEC 7220	3 custom LSI, + 2 add'l w/bit-mapped extension	two custom VLSI
Math coprocessor	8087 (optional)	standard	none
Display	12″ monochrome or color	12″ monochrome or 13″ color	not available; can use composite, RGB or TV set
Text	80×25	80×24 or 132×24	80×25 or 40×25
Graphics	640×400 in 8 fixed colors	960×240 in 8 of a pallete of 256 colors	320×200 in 16 of a pallete of 512 or 640×400 in 2 colors
Memory	64K-512K	512K-1024K	32K-224K plus 32K frame buffer
Memory management	None	Standard	None
I/O ports standard	All optional	two RS-423 serial, for printer, comm	All optional
Disks	one 360K floppy (additional floppy or 10 MB Winchester optional)	two 400K floppies (5 MB or 10 MB Winchester optional)	two 360K floppies (optional) no hard disk
Operating systems	CP/M-80, CP/M-86, MS-DOS, UCSD p-system	P/OS, RT-11, Venix, UCSD p-system, PC-DOS, MS-DOS, CP/M	MS-DOS
Price for a base dev't system*	$5,690	$8,890	$2,287
Price for a graphics development system	$7,250	$11,100	$3,240

**Development system includes a hard disk (except for the Mindset, which does not have a hard disk option) and software to assemble and compile programs.*

in mixing color, the PRO 350 allows only four levels of blue. This is claimed to be because the human eye is half as sensitive to changes in blue as the other two colors.

The restriction to eight colors at a time can be more of a problem. The demonstration of NAPLPS videotex from the Viewtron system which I saw on a PRO 350 had one frame that used more than eight colors and blinking between these colors to produce an animation effect. That frame looked really bad, but the rest of the hundred or so frames looked fine. The original artist might have noticed that certain colors were wrong if the frame had used more than 8 colors, but they looked fine to the casual observer.

Software

Software availability and compatibility may well be the basis on which one of these systems is chosen by many people. Once again, the systems have very different software philosophies.

NCR has opted for maximum compatibility with the existing microcomputer market. If the optional 8088 processor is included, the NCR will run CP/M-80, CP/M-86, MS-DOS, and soon the UCSD p-system. In addition, utilities are provided to segment the hard disk and format each of two pieces for a different operating system and to convert files from one operating system to another. Thus it is compatible with all of the biggest current microcomputer markets.

Although the NCR is not totally compatible with the IBM PC and its clones (and does not claim to be), it and the IBM PC can read each other's disks and run some of each other's programs. Many of the most popular languages and productivity programs, while they may not port directly from an IBM PC, exist in a form approved by NCR to run on the NCR.

This maintains maximum compatibility of the NCR unit with the microcomputer world; that world, however, is not notoriously rich in graphics software—at least, not yet. If your primary intention is graphics in its own right, as opposed to graphics based on data from existing microcomputer productivity programs, the PRO 350 may be more appropriate.

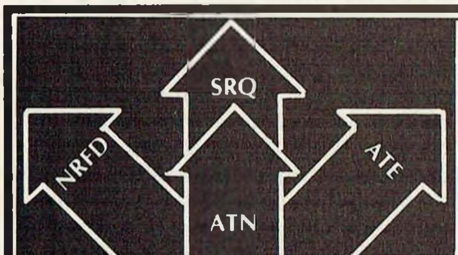
The clearcut differences make it possible to tailor a system to your individual needs.

The P/OS operating system supplied with the PRO 350 is merely a thinly disguised version of RSX-11M-PLUS migrated from the PDP 11 series. Other PDP 11 operating systems, such as RT-11 and Venix are also available on the PRO 350. (Venix is an implementation of Unix Version 7 with Berkeley enhancements, from VenturCom.) Most PDP 11 programs may be ported to the PRO 350 with some effort. Languages supported by DEC on the PRO 350 include Macro-11 (the PDP 11 macro assembler), Fortran 77, Pascal, C, Basic+2, Cobol, DIBOL, and the p-system (layered above P/OS). In addition, there is a CP/M card available from DEC and a PC-DOS/MS-DOS card available from Virtual Microsystems. The PC-DOS/MS-DOS card includes an 8 MHz 8086 CPU, 16K of screen buffer RAM, and an additional 256K of user RAM. *(Editor's Note: Virtual Microsystems claims to be completely PC compatible, including IBM ROM BIOS emulation, PC bit-mapped graphics, and monitor I/O; however, we have not verified this claim. Contact Virtual Microsystems, 2150 Shattuck Ave. #720, Berkeley, CA 94704; (415) 841-9594.)*

In addition, the PRO 350 supports many graphics standards. In release 1.7 of P/OS, these include the ACM CORE standard, through a Core Graphics Library (CGL) available as subroutine calls, and ReGIS (available with the Pro Communications software package), a terminal driver used in much DEC equipment.

In release 2.0, which should be available by the time you read this, the range will be extended to include Tektronix 4014 emulation and NAPLPS decoding. In addition, users are allowed access to the DEC internal standard called GIDIS, an extremely robust standard used to implement all these other standards. Direct access to the graphics bitmap is also possible.

The PRO 350 also provides user access to many of the operating system functions, including text editing, forms management, and communications services. This can significantly shorten development time for applications, as well



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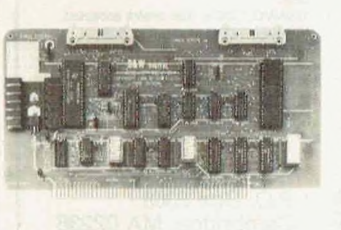
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as lower space requirements for applications, both in memory and on disk.

The Mindset, partly because it is the newest, has the least software support and compatibility. It has a processor compatible with the 8088 and an MS-DOS operating system, plus many additional graphics support functions available to the user in its ROM BIOS. However, its display characteristics differ so greatly from those of other machines such as the IBM PC, that many MS-DOS programs will not run on it directly without conversion.

The current list of software that is either specific to the Mindset, runs on the Mindset, or has been converted to the Mindset fits easily on two pages. Although this can be expected to expand rapidly due to migration of other MS-DOS packages, one current problem is that extended graphics support using their specific hardware and ROM BIOS enhancements is currently available only in assembler and interpreted Basic.

Price. Prices listed (Table 2) are for a fully equipped graphics development system. For the NCR and the PRO 350, this means a system with a 16-bit processor, color graphics and monitor, 512K of RAM, a 10 MB hard disk, one floppy for the NCR and two for the PRO 350, operating system, extended Basic, and one compiled language with graphics support. Note that the software support provided on the PRO 350 in the form of graphics and other tools is significantly greater.

The Mindset, on the other hand, does not come with a hard disk, 512K of RAM, or a compiled language with graphics support. Its price is based on a 16-bit processor, color graphics and a color monitor (of similar quality to those provided by the other two manufacturers), 256K of RAM, two floppy disks, operating system, and extended Basic. A similar configuration of either of the other two systems would cost approximately $3,000 less.

Overall, the prices seem greatly different, but on closer inspection, the differences seem to be based on the hardware features and software support provided. You get what you pay for.

Summary

In general, the graphic characteristics of the various systems suit them to specific markets. The high resolution and limited color flexibility of the NCR, combined with the speed of the 7220 for displaying certain geometric primitives, make the NCR suited to such applications as business graphics or CAD, where many colors or color mapping are of little importance compared to high resolution and drawing speed.

The speed in displaying its own set of primitives, and the price, color flexibility, and slightly lower resolution of the Mindset make it more suitable for animation, games, and videotex, where cost, drawing speed, and esthetics are of prime importance.

The general computing power of the PRO 350 and its uniform high speed for all graphic operations, together with its good resolution and color support, excellent support software, and compatibility with DEC minicomputers make it suitable for a wide variety of markets. While the other systems may be better in their areas, the PRO 350 is the most general system. It is well suited for a large number of more flexible professional applications, such as graphics workstations and development systems, porting the wide variety of minicomputer graphic products to the microcomputer world, engineering and scientific systems, and many others.

The differences are clearcut, and although it may take a great deal of investigation, it is now truly possible to find a graphics system tailored to your individual needs. ◻

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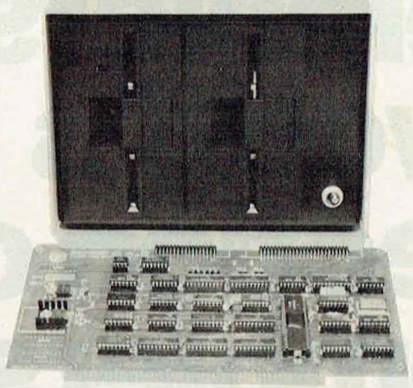

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- A Z-80 to 8086 translator
- 64 page user manual
- 4 linkers included:
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  - –Pure object code generation
  - –Object code and address information only

Linker features:

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- a Z-80/8080 to Z-8000 Assembly Language Source Code Translator
- Z-8000 Macro Cross Assembler and Linker

The Translators provide Z-8000 source code from Intel 8080 or Zilog Z-80 source code. The Z-8000 source code used by these packages are the unique 2500AD syntax using Zilog mnemonics, designed to make the transition from Z-80 code writing to Z-8000 easy.

All 2500 AD Assemblers and Cross Assemblers support the following features:

Relocatable Code — the packages include a versatile Linker that will link up to 128 files together, or just be used for external reference resolution. Supports separate Code and Data space. The Linker allows Submit Mode or Command Invocation.

Large File Handling Capacity—the Assembler will process files as large as the disk storage device. All buffers including the symbol table buffer overflow to disk.

Powerful Macro Section—handles string comparisons during parameter substitutions. Recursion and nesting limited only by the amount of disk storage available.

Conditional Assembly—allows up to 248 levels of nesting.

Assembly Time Calculator—will perform calculations with up to 16 pending operands, using 16 or 32 Bit arithmetic (32 Bit only for 16 Bit products). The algebraic hierarchy may be changed through the use of parentheses.

Include files supported—

Listing Control—allows listing of sections on the program with convenient assembly error detection overrides, along with assembly run time commands that may be used to dynamically change the listing mode during assembly.

Hex File Converter, included—for those who have special requirements, and need to generate object code in this format.

Cross reference table generated—

Plain English Error Messages—

System requirements for all programs: Z-80 CP/M 2.2 System with 54k TPA and at least a 96 column printer is recommended. Or 8086/88 256k CP/M-86 or MSDOS (PCDOS).

Cross Assembler Special Features

Z-8—512 User defined registers names, standard Zilog *and* Z-80 style syntax support.

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6502—Standard syntax or Z-80 type syntax supported, all addressing modes supported.

8086 and Z-8000 XASM includes Source Code Translators

	Z-80 CP/M®	ZILOG SYSTEM 8000 UNIX	IBM P.C. 8086/88 MSDOS	IBM P.C. 8086/88 CP/M 86	OLIVETTI M-20 PCOS
8086/88 ASM			$ 99.50	$ 99.50	
8086/88 XASM	$199.50	$750.00			$199.50
16000(all) XASM *new*	199.50	750.00	199.50	199.50	199.50
68000 XASM *new*	199.50	750.00	199.50	199.50	199.50
Z-8000(TM) ASM		750.00			299.50
Z-8000 XASM	199.50		199.50	199.50	
Z-80 ASM	49.50				
Z-80 XASM		500.00	99.50	99.50	99.50
Z-8 XASM	99.50	500.00	99.50	99.50	99.50
6301(CMOS) *new*	99.50	500.00	99.50	99.50	99.50
6500 XASM	99.50	500.00	99.50	99.50	99.50
6502 XASM	99.50	500.00	99.50	99.50	99.50
65CO2(CMOS) XASM *new*	99.50	500.00	99.50	99.50	99.50
6800,2,8 XASM	99.50	500.00	99.50	99.50	99.50
6801,03 XASM	99.50	500.00	99.50	99.50	99.50
6805 XASM	99.50	500.00	99.50	99.50	99.50
6809 XASM	99.50	500.00	99.50	99.50	99.50
8748 XASM	99.50	500.00	99.50	99.50	99.50
8051 XASM	99.50	500.00	99.50	99.50	99.50
8080 XASM	99.50	500.00	99.50	99.50	99.50
8085 XASM *new*	99.50	500.00	99.50	99.50	99.50
1802 XASM *new*	99.50	500.00	99.50	99.50	99.50
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Digital Research's GSX: Graphics Portability

A step toward a graphics standard: how to use GSX

by William G. Wong

Graphics software is becoming more and more common and important in computer applications. However, in the microcomputer industry, the lack of standard computer graphics interfaces has led to applications programs that must be customized for different machines, or are available for only one machine. The reason for this situation is that the leading microcomputer operating systems (CP/M-80, CP/M-86, Concurrent CP/M, MS-DOS and PC-DOS) provide standard interfaces for disk storage and simple character I/O, but have no similar interfaces for graphics peripherals.

The Graphics System eXtension (GSX) from Digital Research, Inc. (DRI) provides a standard graphics interface for the operating systems mentioned above. GSX complements these operating systems and has a similar structure, as shown in Figure 1. It handles internally all graphics-related service calls from the application program; service calls for disk storage and character I/O are passed to the operating system for processing.

Structure of GSX

GSX, like CP/M or PC-DOS, has two principal components: the Graphics Device Operating System (GDOS), and the Graphics Input/Output System (GIOS). The GDOS, like CP/M's BDOS, provides a standard interface between the applications program and the operating system. There is also a standard interface between the GDOS and the GIOS. Thus, GDOS and BDOS each support a standard set of functions that can be accessed by an application program and that does not change from machine to machine. The GIOS and BIOS consist of hardware-dependent modules that convert service requests to the GDOS and BDOS into commands that are understood by the peripheral devices. The module that controls a specific peripheral is usually called a *device driver*; there is one device driver for each peripheral attached to the system. Thus changing the plotter merely requires that the GIOS incorporate a device driver for the new plotter.

This structure ensures that an application program will run, without modification, on any machine that supports GSX. Of course, peripheral characteristics will affect the results. For instance, a program on a machine with a high-resolution plotter, may draw green, red, and blue circles, while the same program, run on a machine that has only a low-resolution printer, will give only good approximations of the circles in black and white.

GSX environment

GSX is a dynamic system that is loaded before running a graphics program and remains resident until explicitly removed from the system, when no further graphics programs are to be run. This means that the memory overhead for GSX (about 24K) is not incurred unless GSX is loaded.

The loading process brings the GDOS and GIOS into memory. Unlike CP/M's BIOS, which always contains a driver for every character I/O device in the system and is resident at all times, the GIOS contains only one device driver—initially, the driver for the default graphics device. Of course, this does not mean that you are restricted to one graphics peripheral: it merely means that GSX can work with only one peripheral at a time, so only one device driver is loaded at any one time, though the application program can request GSX to abandon the current device driver and load another one instead. This is the *workstation* concept.

A given workstation has one, and only one, device driver associated with it. An applications program can request the opening of a workstation, in the same way that it might request a file to be opened.

Some of the peripherals supported under GSX on the IBM PC are listed in Table 1. You will note that these fall into four device types: displays, plotters, printers, and cameras. Table 2 shows the workstation (logical device) numbers associated with each device class.

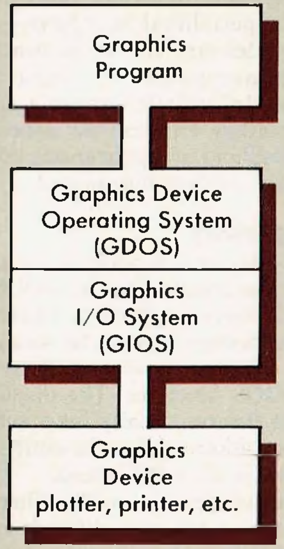

Figure 1. GSX interface.

The association of workstation (logical device) numbers to device drivers is accomplished by means of a file designated ASSIGN.SYS. Each entry in this file consists of a workstation number, the name of the file containing the associated device driver, and (where necessary) a comment preceded by a semicolon.

The following is an example of an ASSIGN.SYS file:

```
 1 A:IBMBLMP2   ;IBM Color adaptor,
                ;MONOCHROME mode
 2 A:IBMBLCP2   ;IBM Color Adaptor,
                ;COLOR Mode
11 B:DD3EPSNH   ;IBM/Epson Graphics
                ;Printer HI RES
21 B:IBMHP742   ;Hewlett-Packard
                ;7470/7475A Plotter
```

This file may be created or modified with the aid of a text editor, or by using the GSX GINSTALL program. This program is menu driven and easy to use; it shows you the current status of the ASSIGN.SYS file and allows you to make changes via menu selection, presenting device driver descriptions instead of merely the rather cryptic filenames. When your selections are complete, GINSTALL saves the new ASSIGN.SYS file and copies all necessary device driver files to the selected program disk. Note that ASSIGN.SYS may specify more than one workstation number of a given class (e.g., the above example specifies two display devices), but a workstation number must be assigned to one, and only one, unique device driver name.

Once ASSIGN.SYS has been set up, running an application program under GSX is easy. For example, to run DR DRAW under PC-DOS you would enter:

```
GSX
DRAW
```

A similar sequence would start any GSX-based graphics application.

GDOS program interface

The program/GDOS interface is very similar to the program/BDOS interface. There is a single entry point that accepts a function code (indicating a GSX call) and a reference to a parameter block. The GDOS performs the function, using the specified parameters, and then returns to the calling program. A status result for the open workstation is returned in the accumulator; any other results are returned through the parameter block. Listing 1 shows typical GSX calling sequences in assembly language for 8- and 16-bit machines. The parameter block, of which the FWA (First Word Address) is given in the calling sequence, contains five references, as follows:

1. FWA of control array
2. FWA of input parameter array
3. FWA if input coordinate array
4. FWA of output parameter array
5. FWA of output coordinate array

In the case of 8-bit machines, these FWAs are 16-bit addresses; in the case of 16-bit machines they are standard 32-bit segment offsets. The arrays themselves are made up of 16-bit integers, regardless of the implementation. The length of each array is dependent upon the function to be performed and is specified in the first part of the control array, as follows:

1. GSX function code
2. Input coordinate array size
3. Output coordinate array size
4. Input parameter array size
5. Output parameter array size

Table 1. GSX drivers

Displays:

Artist2 graphics card
Hercules graphics card
IBM PC color adapter (color mode)
IBM PC color adapter
  (monochrome mode)
IBM 3270-PC adapter
  (hi-res color mode)
IBM 3270-PC adapter
  (monochrome mode)
Plantronics PC+ Colorplus adapter

Plotters:

Hewlett-Packard 7470A/7475A
Houston Instruments DMP-29/4X
Strobe 100/200/260

Printers:

Anadex DP-9001A/9501A/9625A
C. Itoh 8510A
Centronics 351/352/353
Data South DS-180
DEC LA50 and LA100
Diablo C150 Ink Jet
IBM/EPSON graphics printers
IDS Prism 80/132/480
  (monochrome)
Mannesmann Tally MT160
  (hi-res mode)
Okidata MicroLine
  92A/93A/84/92/93
Phillips GP300L
Printronics MVP
Transtar Color

Cameras:

Polaroid Palette

GSX

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Subsequent elements in the control array are dependent upon the GSX function code and are not always required. Note that the coordinate array sizes come before the parameter array sizes; this is done because the GDOS converts the coordinate arrays for the GIOS, and since some conversion is always done, coordinate array sizes must always be given, even if the size is zero.

Table 3 contains a list of the GSX function codes. Most of the functions are used for interrogating and changing the status of the workstation, including such operations as selecting line types (solid, dotted, etc.) or finding our what font is being used. Graphics input devices can also be accessed by means of the GDOS functions; many device drivers include support for keyboards, cursor keys, mice, light pens, touch screens, and graphic tablets. Functions 6-11 are the ones that actually draw. Complex figures, such as arcs and circles, are drawn using Generalized Drawing Primitive (GDP) function #11. Table 4 lists the available GDP functions. The main difference between the GSX polyline and polymarker and the corresponding GDP function is that the latter requires only one call per figure.

Some devices support additional modes and operations, such as reverse video or hard copy output (display devices). These are accessed using the GSX Escape function (#5) instead of enumerating them as primary GSX function codes. Table 5 lists the current Escape functions. Note that both the GDP functions and the GSX Escape subfunctions contain reserved function numbers, as well as unused but available numbers. This means that the GSX can be upgraded by the addition of new operations, while still remaining compatible with existing software.

The GSX functions can support almost any existing graphics device. A device driver should recognize any valid GSX function, even if the device does not support the function—in which case no action should be performed. Devices with new features can be supported through the unused GDP and GSX Escape functions.

The line and marker drawing functions are optimized for multiple segments. This allows an application to generate a set of points and let the graphics device draw each item as fast as possible without requiring the applications program to specify the individual segments. Listing 2 shows the source code for a program that draws a four-sided box after selecting the appropriate line type, width and color. The polyline function allows a single function call to result in the drawing of all four sides, instead of having to perform four function calls, one for each line segment.

Table 2. Logical device numbers

Logical device number	Device class
1-10	Display
11-20	Plotter
21-30	Printer
31-40	(reserved for Metafile)
41-50	Other devices

Table 3. GSX function codes

Function code	Description
1	Open workstation
2	Close workstation
3	Clear workstation
4	Update workstation
5	Escape (device-specific operation)
6	Draw polyline
7	Draw polymarkers
8	Draw text
9	Draw filled area (polygon outline)
10	Display cell array
11	Perform Generalized Drawing Primitive (GDP) such as drawing a circle or an arc
12	Set character height
13	Set text direction
14	Set color representation
15	Set polyline line type
16	Set polyline line width
17	Reserved
18	Set polymarker type
19	Set polymarker height
20	Set polymarker color
21	Set hardware text font
22	Set color index
23	Set interior fill style
24	Set fill style index
25	Set fill color
26	Return color representation
27	Return cell array definition
28	Return locator position
29	Return value of valuator device
30	Return choice device status keys
31	Return string from specified string device
32	Set writing mode
33	Set input mode

The parameter blocks for setting the polyline parameters tend to be large in comparison to the box example. However, the setup is normally done only once, and the figures often consist of more than the four lines required in the example. In that case, more memory is required for the polyline endpoints.

GIOS/GDOS interface

The GIOS/GDOS interface is referred to as the Virtual Device Interface (VDI); this VDI provides a consistent interface for device drivers. Each device driver receives a pointer to the same parameter block that was passed to the GDOS; the main difference is that the GIOS does not require a function code to be passed in a register, since a device driver can work only with its corresponding device.

Normalized device coordinates

It might seem that the GDOS does nothing more than load the device drivers and pass function requests between the application and the driver. In fact, when passing information between the applications program and the GIOS, the GDOS does quite a lot of conversion, because the applications program specifies Normalized Device Coordinates (NDC), whereas the device driver expects Real Coordinates (RC).

The range for normalized device coordinates never changes: it is always 0 to 32,767 for both x- and y-axes. On the other hand, the range for real coordinates may vary from device to device. For example, a typical display device has a range of 0-319 for the x-axis and 0-199 for the y-axis.

One consequence of this mapping is that a figure will always appear on the drawing surface of a device. Also, it is up to the applications program to take into account any aspect ratio that the graphic peripheral may have—otherwise circles may end up as ovals. This may be acceptable in some circumstances. Information about a device's real coordinate system and aspect ratio is available to an applications program when a workstation is opened.

Device drivers

Device drivers perform the graphic operations specified by the GDOS functions. Drivers for displays, plotters and camera devices tend to be straightforward, since hardware operations match the GDOS functions. The display and camera devices usually have sufficient memory allocated for the entire drawing surface of a CRT screen.

Printer drivers, on the other hand, tend to be a bit more difficult because the hardware normally prints one line at a time, whereas GSX expects a two-dimensional drawing surface at all times.

Table 4. General Drawing Primitive (GDP) subfunctions (GSX function 11)

Subfunction code	Description
1	Draw a bar
2	Draw an arc
3	Draw a pie slice (filled arc)
4	Draw a circle
5	Print graphic characters
6-7	Reserved for future use
8-10	Unused and available for special functions

Table 5. GSX escape subfunctions (GSX function 5)

Subfunction code	Description
1	Inquire addressable character cells (return number of rows and columns)
2	Enter graphics mode
3	Exit graphics mode
4	Move cursor up one row
5	Move cursor down one row
6	Move cursor right one column
7	Move cursor left one column
8	Move cursor to home position
9	Erase to end of screen
10	Erase to end of line
11	Move cursor to specified position
12	Output cursor addressable text
13	Turn on reverse video for text
14	Turn off reverse video for text
15	Inquire current cursor address (return current of row and column)
16	Inquire tablet status
17	Make hardcopy
18	Move graphic cursor to specified position
19	Do not display graphic cursor
20-50	Reserved for future expansion
51-100	Unused and available for special functions

GSX printer drivers must therefore perform some special operations to accommodate GSX.

A printer driver should first record all GDOS commands in an *object list* until a workstation update command is issued. The object list is kept in RAM, or on a disk file if insufficient RAM is available. The list is then used to draw an internal copy of the graphics figures in a raster buffer that is also kept in RAM. The internal copy is then printed out, one line at a time.

Unfortunately, the raster buffer can grow quite large if a printer has very high resolution. The DRI printer drivers use an additional step to keep the raster buffer to a manageable size, even though a full-size raster buffer may exceed one megabyte. The figure is logically divided into a number of strips, each of which has the full width of the printer and is some convenient number of printer lines in depth. Thus, each strip may be considered as a window through which to view a portion of the complete figure. The display list is used to draw the figure onto each strip in turn, clipping any drawing operations at the edges of the strip. The raster buffer is then mapped onto the current strip and printed out, one line at a time.

Obviously, this process requires the complete figure to be drawn several times—the exact number depends upon the resolution of the printer and the size of the raster buffer. Low-resolution printers require only a few iterations, while high-resolution printers can require a dozen or more iterations, even with a 40K raster buffer. The disadvan-

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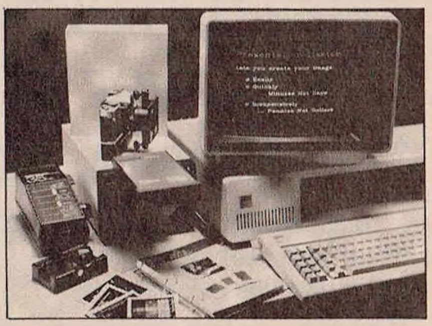

A combination of DRI's DR Graph and DR Draw, Presentation Master is an in-house system of producing color slides and prints from computer graphics files. After designing graphics images with DR Draw and DR Graph, the computer image recorder accepts that data via the computer's color graphics board to reproduce each image on film, simultaneously matching or modifying colors to the user's choice from color exposure tables in the software package. Exposed rolls of 35mm instant film can be processed and mounted as finished slides or color prints in minutes. With DR Draw, users can manipulate lines, text and a variety of symbols, including boxes, circles and arcs to construct organizational charts, logos, area layouts and project flow charts. Picture elements can be moved, copied, scaled and deleted and users can control attributes such as color, line style, typefont and fill pattern. A special zoom feature makes possible intricate or detailed work, and a panning ability lets users look back and forth over an oversized drawing. DR Graph is designed for creating and editing line graphics, step plots, scatterplots, pie charts, bar charts and text-only foils. The user controls axes, labels, annotations, scaling, fonts, color, fill pattern, line style and position. Multiple graphs can be displayed simultaneously on one screen. DR Graph accepts data from Multiplan, VisiCalc and SuperCalc files. All DR Draw and DR Graph functions are menu driven, and accept input through keyboard, light pen or mouse, of which the latter two come with DRI's Graphics Systems Extension (GSX) software, providing interfaces to graphics peripherals. Due to GSX, Presentation Master can offer improved screen resolution and more colors, than are inherent in the hardware. Presentation Master consists of DR Draw, DR Graph, an image recorder, documentation and one roll of instant slide film, sells for $1,999 in the U.S. Available from: **Digital Research Inc.,** *160 Central Ave., Pacific Grove, CA 93950; (408) 649-3896*

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GSX

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tage is that the iterations make the process slow; the advantage is that high-quality graphics can be printed even if only limited RAM is available.

Software

Applications. Programs that use graphics can be purchased from a number of vendors. Three graphic programs from DRI are: DR GRAPH, DR DRAW, and ACCESS 10. DR GRAPH provides business graphics, including pie charts and bar graphs; it can take data from many popular spreadsheet programs and convert it to into graphs, or data may be entered directly from the keyboard. DR DRAW is a very flexible free-form drawing and drafting program; it even includes mouse support on the IBM PC. ACCESS 10 is a Tektronix 4010/14 graphics terminal emulator that allows a microcomputer to be connected to a graphics host computer. Other products using GSX include the SuperCalc 3 spreadsheet from Sorcim and GraphPlan from Chang Labs.

Program development. GSX is normally included with either a graphics application program or the operating system. This environment is intended for running graphics applications programs, although it can be used for program development as well.

> **GSX handles internally all graphics-related service calls from the application program.**

For the more serious programmer there is the GSX-86 Programmer's Toolkit, available from DRI for $350. This package comes with information on the GINSTALL program, including customization notes, the GIOS interface, the GDOS interface, and support for compiled high-level languages. Also included are two diskettes containing device drivers for the IBM PC and more than 20 other drivers (running under PC-DOS, CP/M-86, and Concurrent CP/M-86) for devices ranging from the popular IBM PC color adapter card to the high-resolution Polaroid Palette color camera.

The high-level language support is in the form of language bindings for the 16-bit DRI compiler-based languages including C, Pascal-MT+, PL/I, CBasic, and Fortran-77. A demo program, with source code, is provided for each language. The language bindings allow graphics applications to be developed in a high-level language without having to resort to assembly language interfaces. Support for large and small memory models is included.

The best part of the deal is that the Toolkit comes with a license to distribute GSX with a graphics application to IBM PC, PC-XT, and 3720-PC users without having to pay royalties to DRI. The distribution rights cover the set of drivers supplied with the package. You can also include your own drivers for peripherals not included in the Toolkit set. Also, a Professional Programmer

Text continued on page 81

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Listing 1a. 8-bit CP/M GSX calling procedure

```
BDOS equ 5                      ; OS entry point
GSX  equ 115                    ; GSX function code

MVI  C,GSX                      ; C  := OS function code
LXI  D,Parameter                ; DE := GSX parameter block
CALL BDOS                       ; Perform GSX function
```

Listing 1b. 16-bit GSX calling procedure (CP/M-86, Concurrent CP/M-86, Concurrent DOS, PC-DOS, MS-DOS)

```
OS  equ 224                     ; OS entry point
GSX equ 473h                    ; GSX function code

MOV DX,OFFSET Parameter
MOV DS,SEG Parameter            ; DX:DS := GSX parameter block
MOV CX,GSX                      ; CX := OS function code
INT OS                          ; Perform GSX function
```

Listing 2. GSX line drawing example (8080 assembler)

```
BDOS        equ 5                           ; OS entry point
GSX         equ 115                         ; GSX function code

; ----      DE  - GSX parameter block index  ----
; ----      A  := GSX function result        ----

DRAW:       MVI C,GSX               ; C  := OS function code
            JMP BDOS                ; Perform GSX function


; ----      Draw a box using four line segments  ----

EXAMPLE:    LXI  D,TYPE             ; DE := parameter block
            CALL DRAW               ; Set polyline type
            LXI  D,WIDTH            ; DE := parameter block
            CALL DRAW               ; Set polyline width
            LXI  D,COLOR            ; DE := parameter block
            CALL DRAW               ; Set polyline color
            LXI  D,BOX              ; DE := parameter block
            JMP  DRAW               ; Draw box


; ----      Polyline type parameter block  ----------

TYPE:       DW TPYCA                ; Control array reference
            DW TYPIPA               ; Input  parameter  array reference
            DW 0                    ; Input  coordinate array reference
            DW TYPOPA               ; Output parameter  array reference
            DW 0                    ; Output coordinate array reference

TPYCA:      DW 15                   ; Set polyline type function code
            DW 0                    ; Input  coordinate array size
            DW 0                    ; Output coordinate array size

TYPIPA:     DW 1                    ; Solid line

TYPOPA:     DS 2                    ; Actual line type used

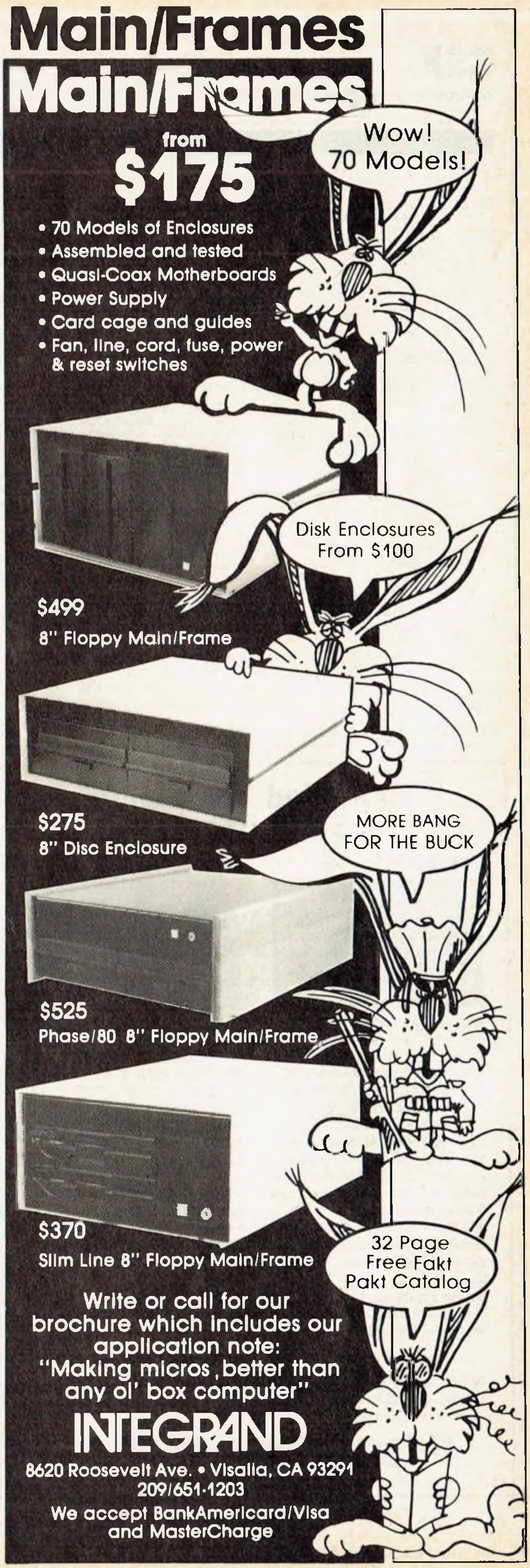

; ----      Polyline width parameter block  -----------

WIDTH:      DW WIDC                 ; Control array reference
            DW 0                    ; Input  parameter  array reference
            DW WIDICA               ; Input  coordinate array reference
            DW 0                    ; Output parameter  array reference
            DW WIDOCA               ; Output coordinate array reference

WIDCA:      DW 16                   ; Set polyline type function code
            DW 1                    ; Input  coordinate array size
            DW 1                    ; Output coordinate array size

WIDICA:     DW 1,0                  ; Line width = 1

WIDOCA:     DS 4                    ; Actual line width used
```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GSX

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```
; ----      Polyline color parameter block   ------------

COLOR:      DW COLC                   ; Control array reference
            DW COLIFA                 ; Input  parameter  array reference
            DW 0                      ; Input  coordinate array reference
            DW COLOFA                 ; Output parameter  array reference
            DW 0                      ; Output coordinate array reference


COLCA:      DW 17                     ; Set polyline type function code
            DW 0                      ; Input  coordinate array size
            DW 0                      ; Output coordinate array size


COLIFA:     DW 1                      ; Color index - 1

COLOFA:     DS 2                      ; Actual color index used


; ----      Box parameter block   --------------------

BOX:        DW BOXCA                  ; Control array reference
            DW 0                      ; Input  parameter  array reference
            DW BOXICA                 ; Input  coordinate array reference
            DW 0                      ; Output parameter  array reference
            DW 0                      ; Output coordinate array reference


BOXCA:      DW 6                      ; Draw polyline function code
            DW 5                      ; Number of vertices
            DW 0                      ; No output parameters


BOXICA:     DW  0,0                   ; Starting point
            DW  0,10                  ; First  line endpoint
            DW 10,10                  ; Second line endpoint
            DW 10,0                   ; Third  line endpoint
            DW  0,0                   ; Fourth line endpoint


; ----------------------------------------------
```

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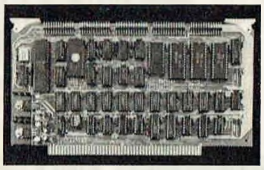

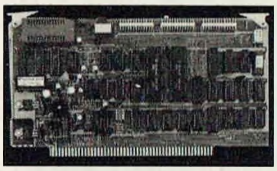

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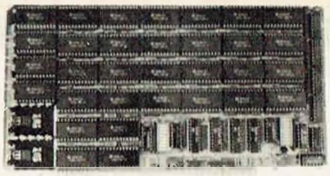

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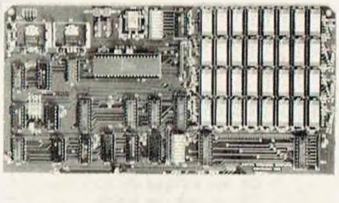

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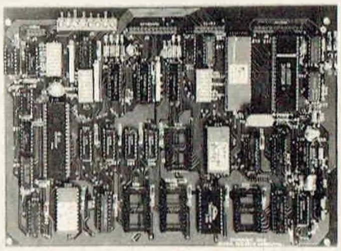

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Model EPROM Capable of either 8 or 16-bit data transfers, this 32/64K EPROM offers the versatility of running with 68000, Z-8000, 8086, 16000, and other 16-bit processors. It accepts industry-standard 2732 and 2716 EPROMs. 64K RAMS may be mixed with 2716 EPROMs for use as a RAM/EPROM board. $345.

Model CPU-68000M High-performance CPU board with 16-bit data path, 10 MHz CPU operation, and MC68451 MMU for multi-tasking applications. $1195.

Model CPU-68000 Similar to 68000M, but features 8K bytes of on-board ROM with Motorola's MacsBug monitor instead of the Memory Management Unit. $895.

Models M/BD-15 & 20 Back Planes These premium quality motherboards feature four-layer construction with two internal ground planes, and Schottky-diode termination. They provide high-speed operation with true transmission line characteristics and minimum noise. M/BD-15: $495, M/BD-20: $545.

Model CMEM This non-volatile CMOS memory board provides easy-to-use 8 or 16-bit data paths and 32K bytes of memory with dynamically movable write/protect window. On-board lithium battery holds data for 3-10 years with power off. $725.

Data Acquisition and Control Boards

Model CLK-24C Clock-calendar features a LSI CMOS chip and on-board, long-life lithium battery. $325.

Model AIM-12 A highly reliable A-to-D converter with 35msec. maximum conversion time, 12-bit resolution and accuracy, and 32 channels single-ended/16 channels differential. $725.

Model AOM-12 This D-to-A converter offers I/O-mapped port address, 12-bit ± 1/2 L.S.B. accuracy (0-70°C), and voltage outputs of 0 to 10 volts, ± 5 volts, and ± 10 volts. $675.

Model VIC 4-20 Converts voltage outputs from AOM-12 into four separate 4-20MA current outputs. Module also provides overvoltage protection on all current output, plus transient protection per ISA standards. $600.

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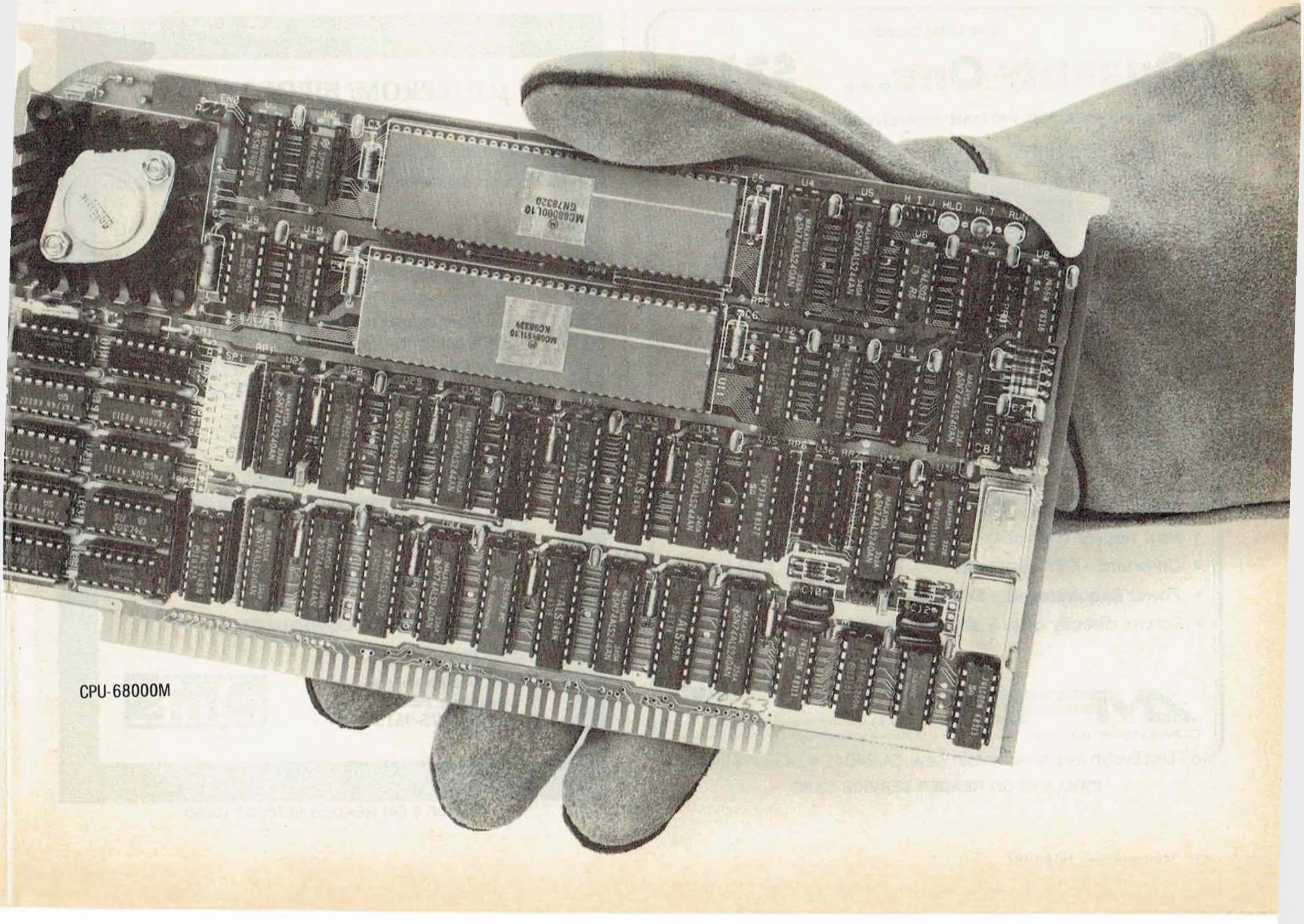

CPU-68000M

GSX

Continued from page 78

Support contract can be purchased with the Toolkit to provide additional GSX support from DRI.

The GSX-86 Programmer's Toolkit is not for everyone. Casual programmers can make use of GSX interfaces supplied with languages such as CBasic without having to purchase the Toolkit.

8087 support

GSX supports the Intel 8087 numeric coprocessor chip in Fortran-77 applications only. The 8087 is not usually used by device drivers, but can speed up translation of normalized to real coordinates. The amount of speed increase depends on the device used and the type of figure being drawn.

Summary

Version 1.3 is the latest release of GSX and is available now. Version 2 is in the works and will be available soon; it will provide better throughput and more graphics functions. New complex drawing primitives, such as ellipses and elliptical arcs, are to be included. Mapping between normalized device coordinates and real coordinates will also be included, and should simplify the development of graphics applications and device drivers. Raster operations, such as contour fill, will be supported. Look for GSX running under UNIX System V, which DRI is putting on the Intel 80286, as well as on new 68000-based machines.

New graphics devices can be installed merely by using GINSTALL.

From a programmer's point of view, GSX has certain limitations: it allows only one workstation to be open at a time, and this prevents sophisticated programs from driving two devices (such as two displays) simultaneously. However, GSX does permit the switching of workstations; DR DRAW, for example, lets you create a figure on a display device and immediately run off a copy on a printer, plotter, or camera device.

GSX offers a standard method of dealing with graphics devices. New devices can be installed, merely by running GINSTALL to include the proper drive. Device drivers are usually supplied by the hardware manufacturer, and this allows a GSX graphics application program to take advantage of new and different peripherals.

Graphics applications programs can be run without modification on any machine that supports GSX. Couple this with the ability to select a wide variety of device, and you get an extremely rich and flexible graphics environment. GSX is definitely a winner.

GSX is available from **Digital Research, Inc.,** *Box 579, Pacific Grove, CA 93950; (402) 649-3896.*

For GSX Programmer's Toolkit contact **Westico,** *25 Van Zant St., Norwalk, CT 06855; (203) 853-6880.*

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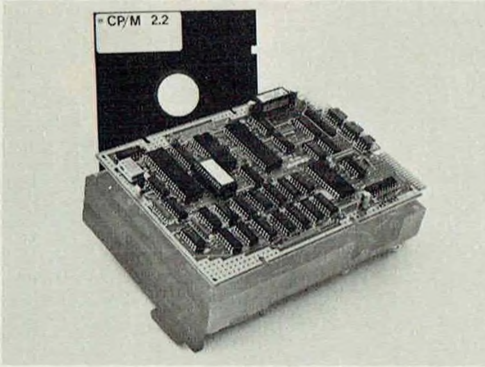

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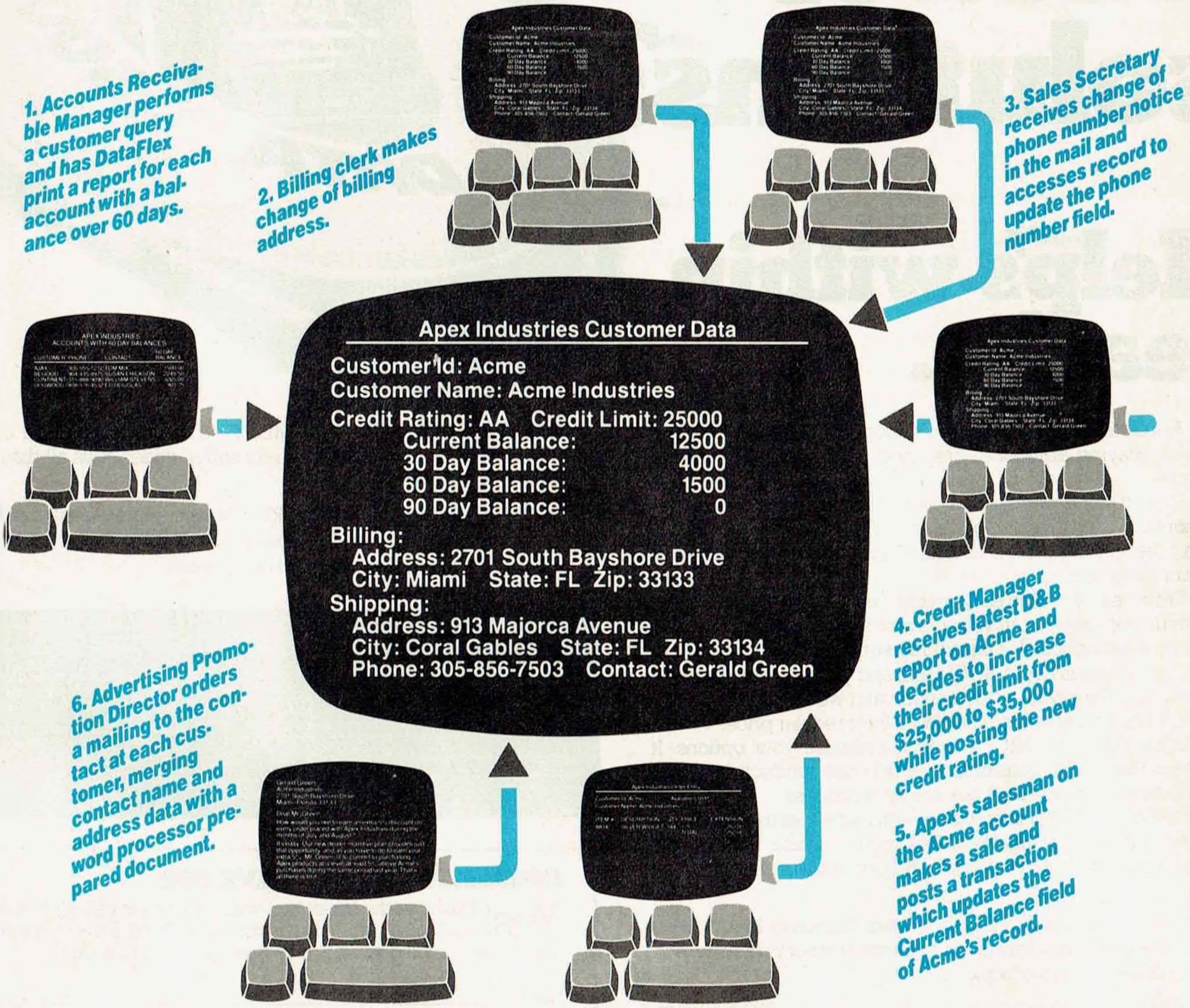

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5. Apex's salesman on the Acme account makes a sale and posts a transaction which updates the Current Balance field of Acme's record.

6. Advertising Promotion Director orders a mailing to the contact at each customer, merging contact name and address data with a word processor prepared document.

```
          Apex Industries Customer Data
Customer Id: Acme
Customer Name: Acme Industries
Credit Rating: AA   Credit Limit: 25000
      Current Balance:          12500
      30 Day Balance:            4000
      60 Day Balance:            1500
      90 Day Balance:               0
Billing:
  Address: 2701 South Bayshore Drive
  City: Miami    State: FL  Zip: 33133
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  Address: 913 Majorca Avenue
  City: Coral Gables   State: FL  Zip: 33134
  Phone: 305-856-7503   Contact: Gerald Green
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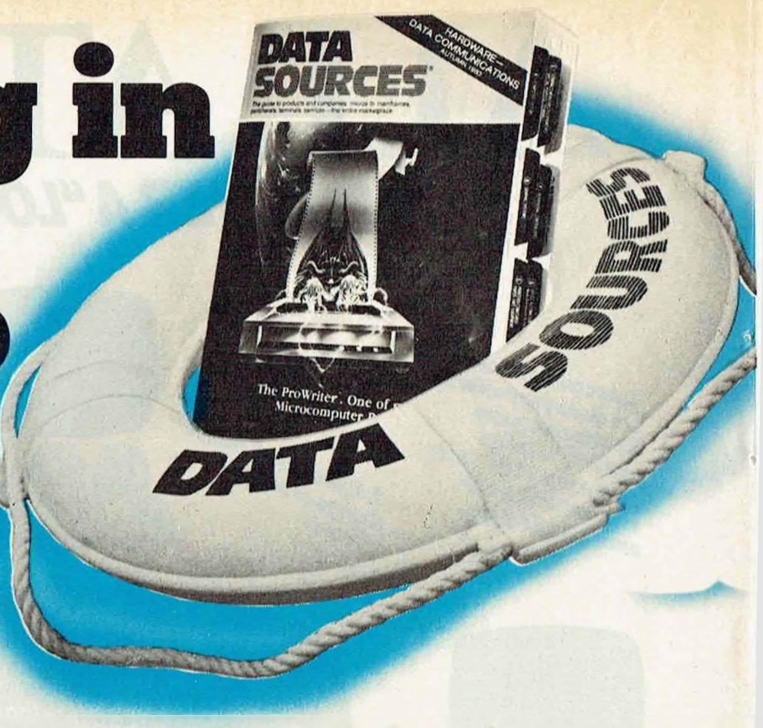

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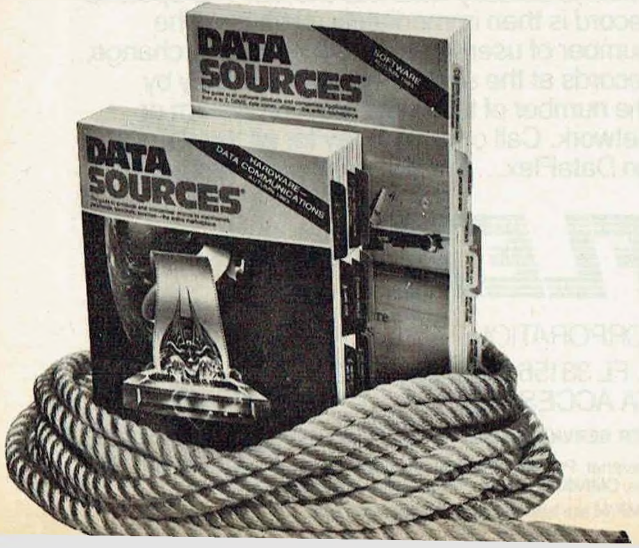

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NAPLPS Directory

by David McCune

Two years ago, NAPLPS vendors were lonely preachers in search of a parish. While parishioners may not yet flock to hear the new graphics gospel, there certainly are a lot more preachers.

The fact that there are now enough micro-based NAPLPS products to form a directory illustrates the most important event in the brief history of NAPLPS videotex: the replacement of expensive, standalone videotex graphics terminals by software running on existing microcomputers. If graphics videotex will ever be carried into the hearts, homes and boardrooms of America, it will be on the backs of millions of micros.

The NAPLPS standard has its roots in videotex. But there is currently only one commercial NAPLPS database in the U.S. The home consumer still has little use for NAPLPS display products. Indeed, the hot topic among NAPLPS vendors is "business videotex," i.e., small videotex systems for boardrooms, lobbies, hotels, shopping malls, etc. This relatively recent concentration on the business market is reflected in the predominance of IBM PC products in the directory.

NAPLPS' newness is emphasized by the almost complete lack of CP/M-based products. Indeed, the rise and reign of CP/M predated NAPLPS by a year or more. Apple's slightly higher-profile penetration of the business market has lead to somewhat greater interest from NAPLPS vendors.

UNIX has just begun to creep into videotex. UNIX' multitasking capabilities are well suited to the requirements of micro-based videotex systems, and NAPLPS vendors will likely follow UNIX' progress closely. And since AT&T is the major corporate proponent of both UNIX and NAPLPS in the U.S., the expected AT&T family of micros will tighten the UNIX/ NAPLPS connection.

Using the directory

NAPLPS products for micros fall into four basic categories:

Decoders: Software or firmware which receives a string of NAPLPS bytes either from disk or from a remote host and translates it into a color video image. The ability of these decoders to fully and correctly display NAPLPS graphics is often limited by the video circuitry on the local micro. (For this reason, many videotex DBMS and frame creation products require external, standalone, full-NAPLPS decoders that connect to the local micro's RS-232 port.) IBM PC decoders often work with various color graphics adapters; the sophistication of the decoder's color handling will vary with the graphics card used.

Videotex DBMS: Database systems which allow one or more users, connected to a micro host, to access NAPLPS graphics. The graphics are usually stored in a hierarchical tree structure. Other functions may include "billboarding," i.e., the system may be able to cycle through a list of NAPLPS graphics, displaying them serially on a local terminal.

Frame creation: Software which allows the user to create and display NAPLPS graphics. These packages often include an interface to a digitizing bit-pad and electric pen.

Software tools: Utilities to aid the programmer in creating NAPLPS software. These tools are usually by-products of a vendor's work on other NAPLPS products and range from libraries of subroutines callable from high-level languages for the creation of NAPLPS code to NAPLPS byte editors and disassemblers.

The directory necessarily lacks detailed descriptions of the products. Where a particular attribute sets a product apart from all others—e.g., a videodisk interface to a DBMS—this is noted in the Comments column. The RAM column indicates minimum memory requirements. Many of these products require special analog RGB or composite video monitors, as noted under Monitor.

The following abbreviations are used:

IBM PC = PC
IBM PC/XT = XT
IBM PCjr. = jr
Apple II = AII
Apple IIe = AE
Apple IIe+ = A+
Analog RGB = RGBA
Digital RGB = RGBD
Composite video = Comp

In spite of a recent scouting trip to the main videotex trade show (Videotex '84) and the scores of phone calls behind this directory, it may not be complete. Companies producing NAPLPS hardware and software for integration into microcomputers are urged to send me information on their products for inclusion in future directories.

---

*David McCune, Proteus Group,
195 Garfield Pl., B'klyn., NY 11215*

Vendor	Decoder	Videotex DBMS	Frame Creation	Software Tools	Name	Requirements: RAM (K)	Requirements: Monitor	Requirements: Other	Comment	Price ($)	RS#
Alphatel		●			Alphatel Apple Telidon Software		RGBA	All, AE, or A+, external NAPLPS decoder	Single-user database	450 (CAN)	1
		●			VSS	128	RGBA	PC, XT, QNX, external NAPLPS decoder	Multiuser database, max. 16 users		
Ashdune Software, Inc.	●	●	●		IIS (Integrated Information System)	48	Comp	All, AE, A+, Commodore 64	Bundled system; frame creation, single-user DBMS, comm. support, handcopy to Apple dot matrix pr.	199 (CAN)	2
Avcor	●				JORDAN			Commodore 64, compatible color monitor		99.95	3
Barros & Associates Ltd.		●			Videophile	192		PC, XT, PC+, NAPLPS decorder (external or Quickpel)	Single-user database	825	4
Cableshare, Inc.			●		Picture Painter	128	RGBA	NAPLPS decoder, Graphics tablet, 2 RS-232 ports, PC, XT, DEC Rainbow (CP/M-86), RAIR (CP/M-80)	Also availale with internal NAPLPS software decoder on IBM PC	4,000 (includes graphics tablet)	5
Cableshare, Inc.		●			Touch 'n Shop	192		PC, XT, DEC, Rainbow, DEC Micro 11 (memory is terminal dependent), optional touch-screen monitor, optional video-disk player, external NAPLPS decoder		6,000 +, depending on config.	5
Digital Equipment Corporation	●	●			PRO/Videotex			DEC pro 350, 10-MB disk, extended bit-map option, color monitor		895	6
Electrohome Electronics				●	Software Devel. Tools			UNIX	NAPLPS disassembler, assembler, C, subroutines for NAPLPS creation	15,000	7
Electronic Office Systems Ltd.	●				MVT-8024 Videotex Terminal			Includes hardware	Full NAPLPS plus Prestel & CEPT videotex graph. standards.CP/M-80 system	1,500	8
FBN Software, Inc.	●				FBN NAPLPS Decorder	40	RGBD	PC, XT, jr, requires RGBA when used with color-mapped board	Full color-mapped NAPLPS when used with Realcolor adapter	160	9
Formic Videotex Systems			●		Artformation		RGBD or Comp	All, AE, A+, NAPLPS decoder, proprietary Formic ROM card		2,000	10
		●			Vuformation					configuration dependent	
		●			Multitel						
				●	Basitel					800	
IBM	●				PC/Videotex	128	RGBD	PC, XT, jr, requires RGBA if used with color-mapped board	On PC and XT, supports IBM graph. adapt., Plantronics Colorplus, and Realcolor (color mapping)		11

Vendor	Decoder	Videotex DBMS	Frame Creation	Software Tools	Name	Requirements			Comment	Price ($)	RS#
						RAM (K)	Monitor	Other			
Limicon, Inc.			●		ProDraw			Hardware incl.		6,400	12
Manitoba Telephone System	●				Viodeotex decoder software			Commodore 64 with color monitor, modem, disk drive		99.95	13
Media Videotex Corp.		●			Medianode-8			Enhanced XT. videodisk			14
Micropixel, Inc.	●				Quickpel	96	Comp	PC, XT, PC+	Firmware decoder plugs into PC bus. On-board 8088 can execute "telesoftware."	625	15
Microstar Software Ltd.	●				Microstar videotex Interpreter	192	RGBD	Entire PC line and compatibles, graphics adapt.		240	16
Microtaure Inc.	●	●	●		TELIgraph	256	RGBD	PC with both monochrome and color adapters		398	17
PDI		●			Unitasc		UNIX			20,000 (16 ports)	18
Sony Communications Products Company			●		FCX-1000			Includes hardware	NAPLPS video digitizer also available		19
Tayson Information Technology, Inc.		●	●	●	VAST	128	RGBD	PC, XT, (192K RAM), PC+, 2 RS-232 ports, NAPLPS decoder, monochrome		1,000 (CAN $)	20
TV Ontario			●		Createx-C	128		PC, XT, PC+, NAPLPS decoder, RGBA or RGBD (depending on decoder)		1,450	21
Verticom, Inc.	●				PLP100 &PLP200			Includes hardware		5,650+	22
			●		Frame Editor		RGBD	PC, XT, plus NAPLPS decoder		500	
				●	PASS			Fortran 77		200	
Videotex Atlantic Ltd.		●			Selltex, Tourtex, ESD-2000		RGBA or comp	All, Ae, A+, external NAPLPS decoder + monitor		varies with configuration	23
Wolfdata, Inc.	●				Wolfdata NAPLPS decoder software	128	RGBD	PC. Plantronic Colorplus		200	24

NAPLPS Directory

Continued from page 87

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2 **Ashdune Software, Inc.**
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Nepean, Ontario
Canada K2H 7T9
(613) 596-5686

3 **Avcor**
512 King St. East
Toronto, Ontario
Canada M5A 1M1
(416) 864-9240

4 **Barros & Associates Ltd.**
154 Queen St. South, #112
Streetsville, Ontario
Canada L5M 1K8
(416) 858-1043

5 **Cableshare, Inc.**
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London, Ontario
Canada N6A 4L6
(519) 686-2900

6 **Digital Equipment Corp.**
(available only through
a local distributor)

7 **Electrohome Electronics**
809 Wellington St. North
Kitchener, Ontario
Canada N2G 4J6
(519) 744-7111

8 **Electronic Office Systems Ltd.**
191A Ben Yehuda St.
P.O. Box 45266
Tel Aviv 61452
Israel

9 **FBN Software, Inc.**
331 Cooper St., #400
Ottawa, CA
Canada K1P 0G5
(613) 238-1761

10 **Formic Videotex Systems**
8571 St-Denis
Montreal, Quebec
Canada H2P 2H4
(514) 384-2655

11 **IBM Corp.**
Department 825
1133 Westchester Ave.
White Plains, NY 10604

12 **Limicon Inc.**
144 Hampton Ave.
Toronto, Ontario
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(416) 481-7859

13 **Manitoba Telephone System**
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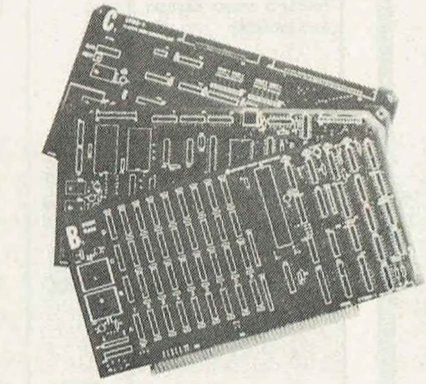

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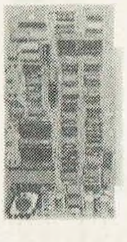

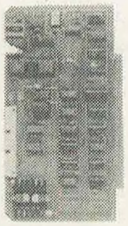

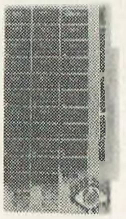

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Color Graphics for any Computer with the VectorScan 512

An RS-232 color graphics peripheral

by Ron Lusen

Computer graphics is one of the fastest growing segments of the computer industry, and nowhere is this more apparent than in the microcomputer arena. Many microcomputers, such as Apple, Atari, and Commodore, have color graphics as an integral part of their systems, while S-100 computers allow for expansion that may include color graphics, and the IBM PC and its clones have expansion slots. Still others, however, have no provision for color graphics. This last case includes many mini and mainframe computers. It is nevertheless possible to add color graphics capability to almost any computer, including those that already have some. In fact, color graphics can be added to any system with a serial or parallel communications capability.

Several products have come on the market that are essentially black boxes with connectors for a color monitor. The communications line may be serial or parallel, depending on the manufacturer. One such product is the VectorScan 512, made by Applied Data Systems.

General description

The VectorScan 512 is a graphics display controller for high-resolution color or monochrome graphics. It attaches to a computer via a serial RS-232 line, and to a display by either a RGB video output for high-resolution color graphics, or a composite video output for use with a monochrome monitor. It accepts ASCII character string commands which cause it to create images on the display monitor, or to perform any of its other functions.

Features

The spatial resolution of the image in the VS512 memory is 512 by 512 pixels, of which 512 horizontal by 480 vertical are displayed on the screen. The display can be scrolled or positioned vertically to view any 480 consecutive lines of the 512 in image memory. The color resolution is 4 bits or 16 colors.

Commands are sent to the VS512 as a string of printable ASCII characters. Thus images can be created using any computer language, even a text editor. (This also means that the VS512 can be used with computers that trap or otherwise do undesirable things to control characters.) The VS512's firmware has a repertoire of built-in commands that include line, arc, circle, point, programmable shape, and more. The firmware also contains graphics drivers for a

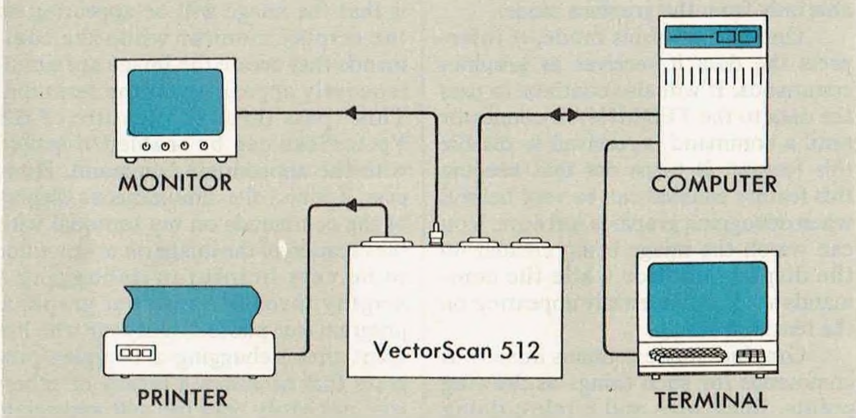

Figure 1. Connection to a dedicated port.

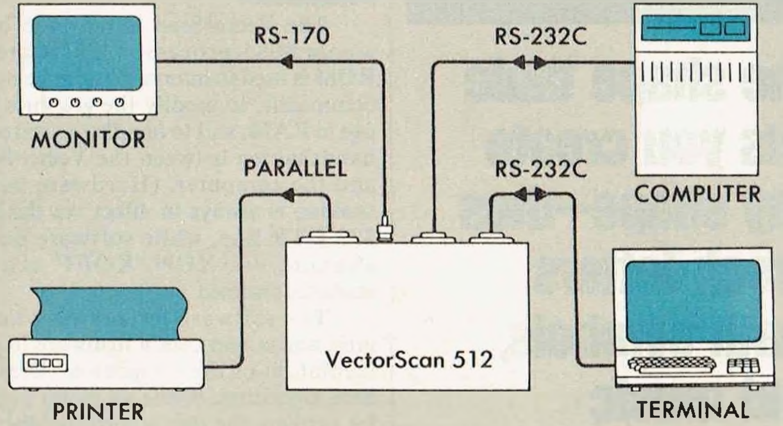

Figure 2. Connection to a terminal port.

number of dot matrix printers (including the IDS PRISM printers), thus producing graphics hard copy in black and white or color.

Another feature is a down-loadable, or programmable, shape table. The shape table allows for the creation of any shape, closed or disjointed, that can be defined by a set of vectors. Thus Greek letters, math symbols, music notation, or anything else can be created and easily drawn on the screen. Although there is no limit as to size, this feature is really meant to be used with small shapes. Once the shape table has been created, a shape can be placed anywhere on the screen with a single command. The shape will be drawn with the currently selected color and the currently selected text scale factors. With properly selected colors, shapes and characters can be erased without disturbing the underlying or background color. This mechanism can be used to create limited animation of small objects.

A different kind of animation, generally referred to as color table animation, can be created with the color mapping register feature. This feature allows for instantly redefining the colors that currently appear on the screen. For example, all pixels that are green can be changed to bright yellow. This could be done by rewriting every green pixel on the screen, but would be very slow. Rather, a single command that redefines the value of green to bright yellow will cause the change to occur instantly (i.e., within the vertical blanking period) over the entire screen. Typical examples of color table animation are zooming through a tunnel, flowing water, and rays of light.

The VS512 has a very interesting "extra" feature. When not being used for graphics, the RAM memory in the unit can be used as a print buffer. With 128K RAM, that's a sizable buffer. It does not have the bells and whistles of today's print buffer products, such as multiple copy or pause functions, but it comes essentially free with the VectorScan. It would be nice if Applied Data Systems were to add some of those print buffer features.

Hardware

The VectorScan 512 is housed in an attractive metal box approximately 10″ wide by 4½″ high by 6½″ deep. The power switch and all connectors are on the rear surface (see photo 1). In addition to the power cord connector, there are five connectors labeled TERMINAL, COMPUTER, PRINTER, RGB, and VIDEO. The one labeled COMPUTER is not only for connection to a computer, but can also be connected to a modem for use with a remote system. The TERMINAL connector need not be used. Its presence allows the VectorScan to be inserted between a computer and a terminal or between a terminal and a modem. More on this later. The PRINTER connector is a standard Centronics parallel interface and thus can be used with any printer having a Centronics interface.

Two connectors are provided for graphics output to a monitor. The RGB connector is a 9-pin type D connector with RGB and sync signals for driving an RGB color monitor. The output signals are Red, Green, Blue, Intensity, Horizontal sync, Vertical sync, and Ground. Sixteen colors can be displayed simultaneously. All signals are positive TTL levels, which provides IBM PC compatibility. Thus, any one of the many color monitors being marketed for the IBM PC can be used with the VectorScan 512. The VIDEO connector is a BNC type that provides a composite video and sync signal for driving a low-cost monochrome monitor. Sixteen gray levels can be displayed simultaneously.

Inside the housing is a single PC card that contains an 8085 microprocessor, up to 8K of ROM and 4K of RAM, plus 128K of RAM for the graphics image (see photo 2).

Software

A standard 8″ SSSD CP/M floppy disk came with the VectorScan. It contains 15 files of ASCII commands, each of which creates a color image on the RGB monitor attached to the unit. Also on the disk is a demo program that continuously cycles through seven of the demo files, displaying each one for a short period. The demo program is provided both in assembly language and in executable form. It is easy to modify for use with any other image files, including your own. Creating the image files is very easy, as described below.

All of the commands that the VectorScan responds to are contained in firmware in an on-board PROM. The PROM can be readily replaced in the

VectorScan 512

Continued from page 93

field whenever updated firmware is provided. Custom firmware for any application is an option. The firmware executes seven control commands and several dozen graphics commands. It also takes care of such things as handshaking and buffering the input stream, printer spooling, and dumping the screen image to a graphics printer. The control commands determine in which of four modes the unit will operate. These are the transparent, graphics, hardcopy, and spooler modes.

The graphics commands include those for drawing points, lines, circles, and arcs; for doing color selection; and for screen and area fill. Also included are commands to display text in either vertical or horizontal format using a built-in ASCII character set. Text may be positioned anywhere on the screen and scaled in both the x and y directions. A down-loadable shape table can be used to provide a user-programmable character set.

Installation

After removing the VectorScan from its shipping carton, installing it is a simple matter of plugging in the power cord and some cables. A minimum of two cables is required, one to connect the unit to a computer and the other to connect it to a color or black and white monitor. Additionally, a printer and/or a terminal can be plugged into the VectorScan. If necessary, baud rate and data format DIP switches on the PC board can be adjusted (see photo 2).

The VectorScan can be connected to a dedicated computer port (Figure 1), to the computer's printer port, or to the computer's terminal port. The latter (Figure 2) is the simplest arrangement and the one that I have been using. All I had to do was unplug my terminal from the computer and plug it into the VectorScan, plug the VectorScan into the computer, connect my high-resolution RGB color monitor to the VectorScan, and I was in business.

Operation

The operation of the VectorScan 512 is very straightforward. Of the four modes in which it operates (transparent, graphics, hardcopy, and spooler mode), its power-on default status is the transparent mode. As you may guess, in this mode the VectorScan passes all data between its COMPUTER connector and its TERMINAL connector. Thus it is "transparent" to the system. This is what allows it to be located between the computer and a terminal. It is, of course, constantly scanning the data, looking for the one control sequence that takes it out of transparent mode and into graphics mode. The other two modes are reachable only from the graphics mode.

Once in graphics mode, it interprets the data it receives as graphics commands. It will also continue to pass the data to the TERMINAL connector until a command is received to disable this feature. It turns out that keeping this feature enabled can be very helpful when debugging graphics software. You can watch the image being created on the display monitor while the commands are simultaneously appearing on the terminal screen.

Graphics mode contains numerous commands for such things as drawing points, lines, arcs and circles, doing polygon fills, screen fills, setting colors, enabling and positioning the graphics cursor, and placing horizontal or vertical text on the screen. There are also commands for doing a screen dump to the printer, and for going into print spooling mode. (The VectorScan's firmware contains drivers for Epson, Okidata, and Prism Color printers. Additional drivers may be included in later versions.) All told, there are several dozen graphics commands.

The shape table lets you create any shape—thus Greek letters, math symbols, and music notation can be drawn.

Since all of the commands for the VectorScan are ASCII printable characters, a display file can be created or edited with a text editor as well as with a graphics program. While commands can be sent directly to the VectorScan by a program, there are advantages to creating a display file. Not only can the file be sent to the VectorScan, but it can also be directed to a printer or listed on a terminal. If the unit is located between the computer and a terminal, simply listing the display file on the terminal will activate the VectorScan. The result is that the image will be appearing on the display monitor while the commands that create the image are simultaneously appearing on the terminal. This "pass through" feature of the VectorScan can be enabled/disabled with the appropriate command. However, I found the simultaneous display of the commands on my terminal with the creation of the image on my monitor to be very helpful in debugging a lengthy three-dimensional graphics program (see photo 3). Anyone who has spent time debugging a complex program that produces a binary or otherwise not easily read file will appreciate this feature.

Performance

The VectorScan is powered by a single 8085 processor. Software in ROM is used to interpret and execute all commands, to modify the graphics image in RAM, and to handle the software handshaking between the VectorScan and the computer. (Hardware handshaking is always in effect via the RS-232 DTR line, while software handshaking via XON/XOFF can be enabled/disabled.)

The software for drawing lines, arcs, and circles uses a firmware implementation of the ubiquitious Bresenham algorithm. While all raster graphics systems use this algorithm, the big difference in performance is usually due to how this algorithm is implemented. Very high-performance systems (read very expensive), such as realtime flight simulators, implement this (and other algorithms) in hardware. Moderate-performance systems, including some microcomputer systems, use special graphics processors. Low-performance systems, such as many microcomputers, let the applications program do all of the work. Needless to say, higher performance usually means higher cost.

The cost/performance tradeoff used by the VectorScan designers was aimed at achieving high resolution, reasonable performance, and low cost. The result is that reasonably complex drawings can be displayed in a matter of seconds. For example, a Clear Screen command takes about two seconds. A mechanical drawing of the back panel layout of the VectorScan unit, dimensions included, takes about 8 seconds (see photo 4). So does the drawing of the space shuttle, with several sizes of text (see photo 5). Two- and three-dimensional business charts, which make extensive use of the polygon fill command, may take 10 or 20 seconds (see photos 6 and 7). A three-dimensional wire frame

Photo 1. *View of rear panel, showing power switch and five connectors.*

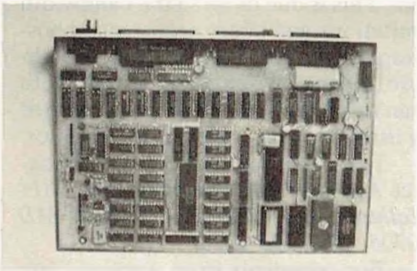

Photo 2. *VectorScan 512 PC card.*

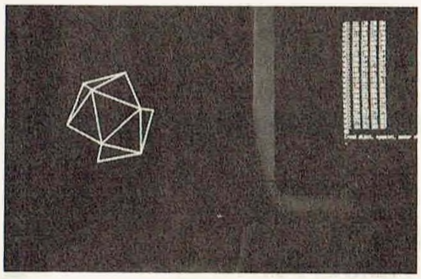

Photo 3. *Simultaneous display of commands on the terminal with the creation of an image on the monitor.*

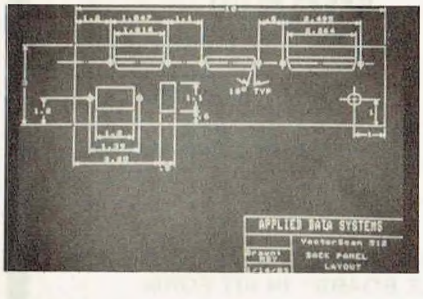

Photo 4. *A mechanical drawing of the VectorScan unit, with dimensions included.*

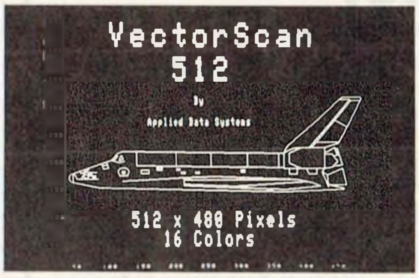

Photo 5. *A rendering of the space shuttle by the VC512.*

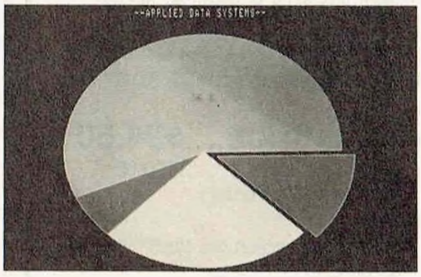

Photo 6. *Two-dimensional business chart, with extensive use of the polygon fill command.*

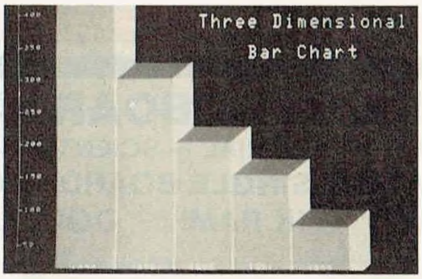

Photo 7. *Three-dimensional business chart, using the polygon fill command.*

object, made up of a dozen polygons, may take several seconds or so. Color table animation, using the color mapping register, is essentially instantaneous. Cycling through all 16 colors takes a fraction of a second.

Documentation

The VectorScan 512 Programmer's Manual is 37 pages, 8½" by 11", spiral bound. It has general sections on Introduction, Overview, Installation, and Operation. Under Operation, after general subsections on Setup, Operational Modes, Control Commands, and Graphics Commands, individual explanations of all 36 graphics commands are given. The manual contains eight appendices, but does not have an index, which I believe should be a mandatory part of any technical document. Here the lack is not as severe as it would otherwise be, since the table of contents lists every graphics command. Another missing item that should be in any technical publication is the publication date. However, I recently received an updated ROM and manual, and the manual does have a version number (version 1.3) on the cover. The new manual describes several new commands that have been added to the firmware. One in particular adds additional capability for animation and special effects by allowing bit plane manipulation. However, I have not had a chance to try the new commands.

Almost all command descriptions include an example of the specific command format. The commands are, for the most part, clearly explained and easily understood. Only one command description left me somewhat puzzled as to exactly what it does. In spite of these minor complaints and a few typographical errors, the manual is generally well written and quite clear, particularly the general information section.

Support

In the several telephone contacts I have had with Applied Data Systems, they have always been cooperative and helpful in providing information and suggestions. (Would that we could say that about all vendors in this business.) They are continually working on improving the ROM-based software by adding new commands. Replacement ROM chips with upgraded software are made available when released and can be replaced in the field. Custom software can be provided for special applications.

Comments

The VectorScan 512 is useful for many types of graphics, ranging from business and CAD/CAM applications to art and games. The animation features combine the shape tables of the Apple II with the color table animation of the Atari. Black and white or color hard copy is available with an appropriate printer. Film output can always be obtained by simply photographing (carefully) the monitor screen. See the accompanying photographs for examples of this.

Drawing time of detailed images may be noticeable, but higher performance can cost a lot more money. There are some graphics add-on products available for microcomputers that achieve higher performance by using a special graphics processor, such as the NEC 7220 graphics chip. One product in particular, similar to the VectorScan in that it is a "black box" graphics display controller, has slightly better spacial resolution and much better color resolution. It uses the NEC chip and achieves much higher performance, but it costs many times more than the VectorScan. The point is that there are many tradeoffs that can be made in designing a graphics display controller. Applied Data Systems chose to go with an easy-to-use, modular add-on unit with very good spacial resolution, good color resolution, reasonable perfor-

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VectorScan 512

Continued from page 95

mance, and relatively low cost. The VS512 nicely fits a market niche for add-on high-resolution color graphics for almost any computer.

To use the VectorScan for color output, you need a high-resolution RGB color monitor. There are now a number of such monitors on the market, and any that are IBM PC compatible work with the VectorScan. One final point concerning monitors is that a slight amount of flicker may be noticeable on horizontal lines on some monitors. This is due more to the bandwidth limitations and short-persistence phosphors used in the current crop of high-resolution, low-cost RGB monitors than to VectorScan. It can be eliminated by using a higher-performance monitor.

For more information, please contact **Applied Data Systems, Inc.,** *9811 Mallard Drive, Suite 213, Laurel, MD 20708; (301) 953-9326.*

For comments from Applied Data Systems on this article, please see "Letters to the Editor," page 37.

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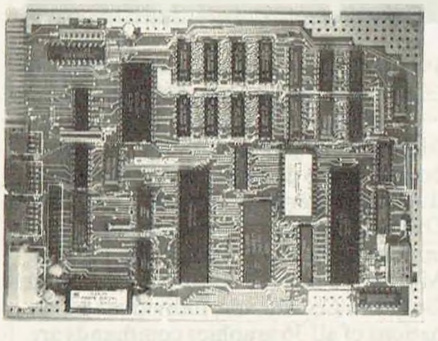

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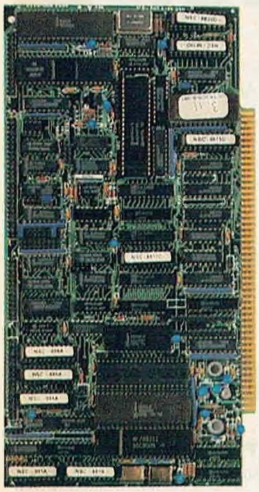

1 CPU 8/16

- Dual processors: 4MHz NSC800 (executes full Z80 instruction set) and 8MHz Intel 8088.
- Onboard floppy controller with 24-bit DMA. Runs up to four 5¼" or 8" floppies in any combination at the same time.
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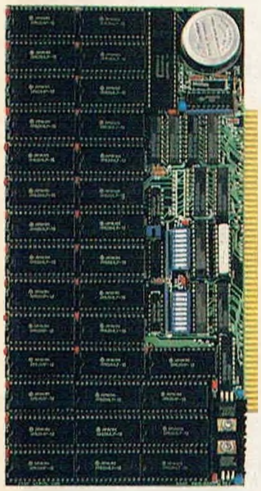
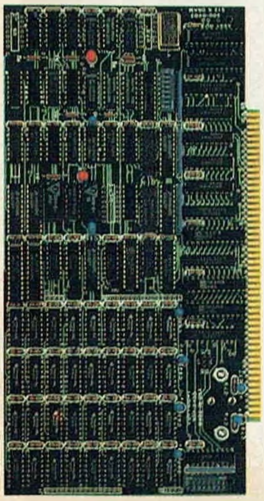


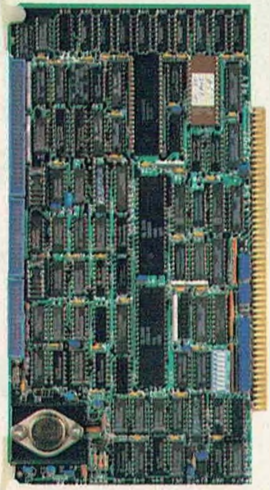
2 256K STATIC RAM/ TIME OF DAY

- Employs fully static CMOS memory chips.
- Accepts either 8-bit or 16-bit bus requests.
- Includes battery-backed-up time-of-day clock and calendar.
- IEEE-696/S-100 compatible.
- $1850 (Manual only: $25)



3 256K/512K/1MB/2MB DYNAMIC RAM

- Configurable as either dynamic RAM or as disk drive emulator.
- Accepts either 8-bit or 16-bit bus requests.
- Uses 256K chips for 1MB or 2MB configurations.
- 150ns. RAM chips.
- IEEE-696/S-100 compatible.
- Low as $850 (Manual only: $25)

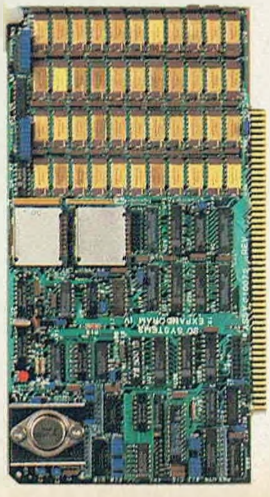


4 SBC-300

- Single board computer able to perform as permanent bus master or slave processor.
- Z80* CPU: 4 or 6MHz.
- 64K of dual-ported RAM with parity.
- 2 to 16K bytes of PROM.
- System memory addressing to 16MB.
- Serial, parallel and counter/timer I/O.
- SASI port.
- Dual programmable serial full-duplex channels.
- Supports CP/M* Plus, MP/M* and TURBODOS*
- IEEE-696/S-100 compatible.
- $740 (Manual only: $25)

5 VFW-III

- Offers simultaneous control of up to three 5¼" Winchester drives (up to 16 heads) and four 5¼" and 8" floppy drives.
- Floppy drives may be single- or double-sided, single- or double-density.
- Data transfers under DMA or programmed I/O control.
- Phase lock loop data separator.
- 20-bit single and 4-bit double burst detection span on 256 byte sectors.
- IEEE-696/S-100 compatible.
- $895 (Manual only: $25)



6 EXPANDORAM IV

- Capacity of 256K RAM (using 64K RAM chips) or 1MB (using 256K RAM chips).
- DIP switch selectable addressing.
- Supports both 8-bit and 16-bit data transfers.
- Refresh control.
- Parity check.
- Optional error detection/correction.
- IEEE-696/S-100 compatible.
- $1145 (Manual only: $25)

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7 VERSAFLOPPY II

- Controls up to 4 floppy drives in simultaneous 5¼" and 8" combinations.
- Provides control for double-sided operation.
- Operates with Z80,* 8080 and 8085 CPUs.
- Vectored interrupt operation optional.
- Control and diagnostic software available in PROM.
- IEEE-696/S-100 compatible.
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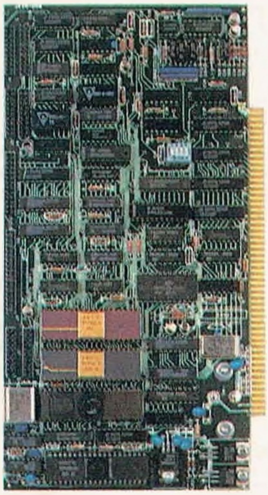

8 HARD DISK CONTROLLER

- 2 serial ports (software selectable up to 19.2K Baud).
- 1 printer port (IBM-PC* compatible).
- Supports up to four 5¼" Winchester drives (ST506 interface).
- ECC/CRC
- Phase lock loop data separator (requires no timing adjustment).
- Full sector buffering.
- Includes both CP/M 80* and CP/M 86* BIOS.
- IEEE-696/S-100 compatible.
- $595 (Manual only: $25)

9 HARD DISK SUBSYSTEM

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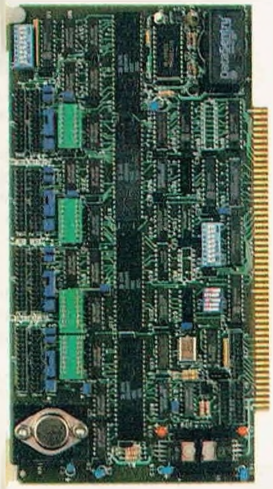

10 I/O 8

- Available in 3 versions: I/O 4 Asynch with 4 asynchronous serial channels. I/O 8 Asynch with 8 asynchronous serial channels. I/O 4 Synch/4 Asynch with 4 serial channels configured for synchronous or asynchronous and 4 asynchronous-only channels.
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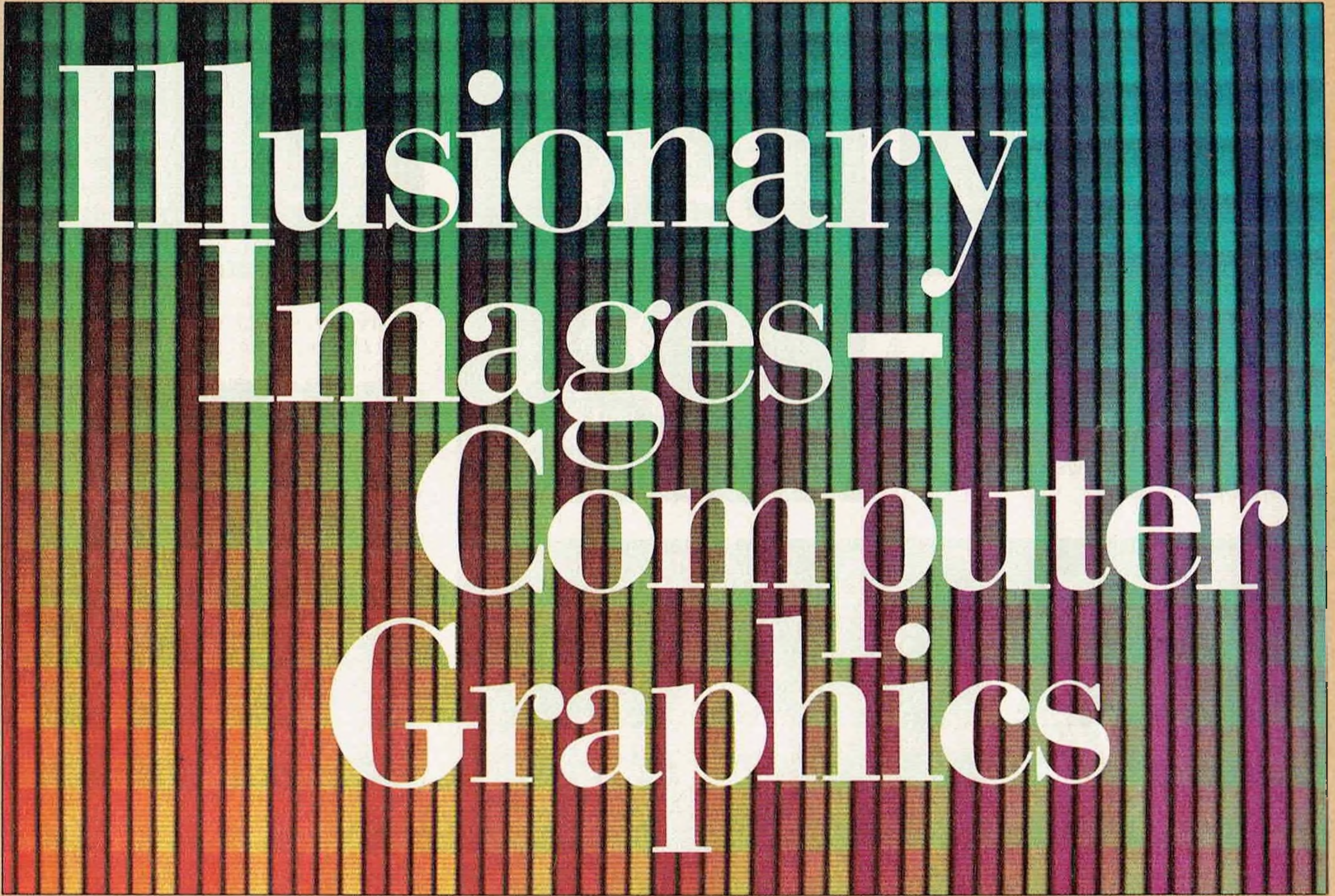

A representative sample of microcomputer graphics images

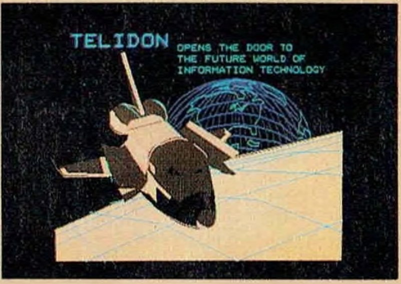

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Figure C-2. *NAPLPS (courtesy of Digital Equipment Corp.)*

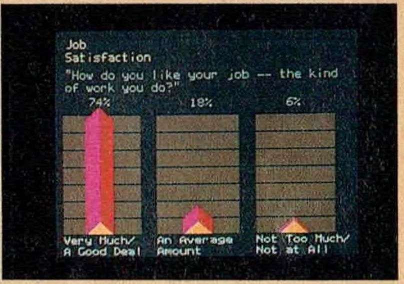

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Figure C-3. *NAPLPS (courtesy of In Time Design Studio)*

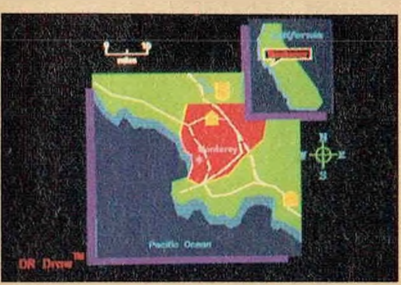


Figure C-4. *DR DRAW (courtesy of Digital Research, Inc.)*

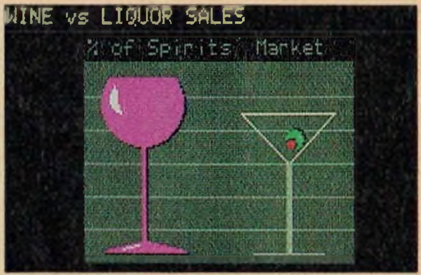


Figure C-5. *NAPLPS (courtesy of Time Video Information Services)*

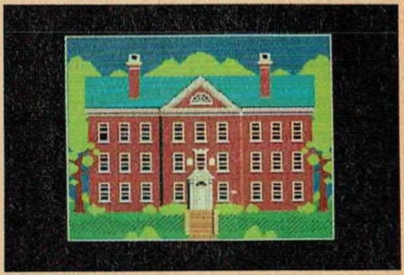


Figure C-6. *NAPLPS (courtesy of In Time Design Studio)*

▲ **Figure C-1.** *(Top) High resolution (courtesy of HBO Graphics Lab.)*

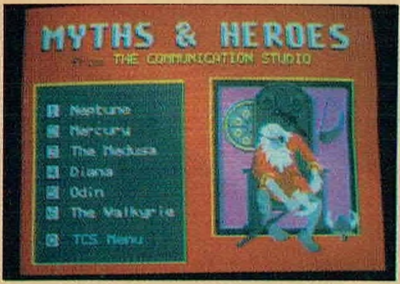


Figure C-7. *NAPLPS (courtesy of The Communication Studio)*

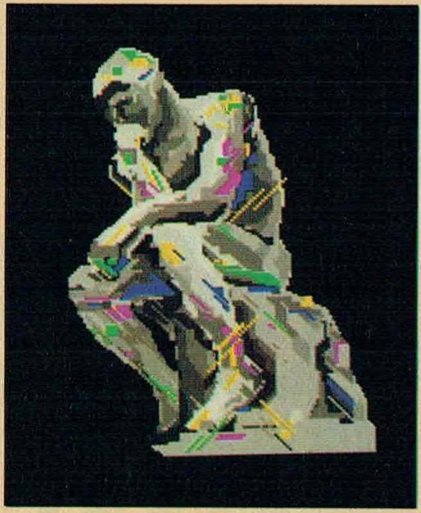


Figure C-8. *NAPLPS (courtesy of In Time Design Studio)* →

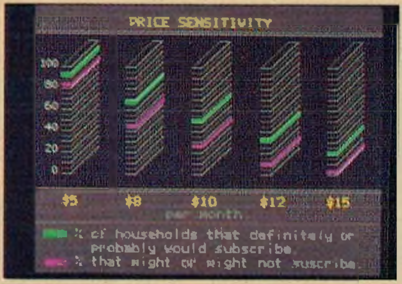
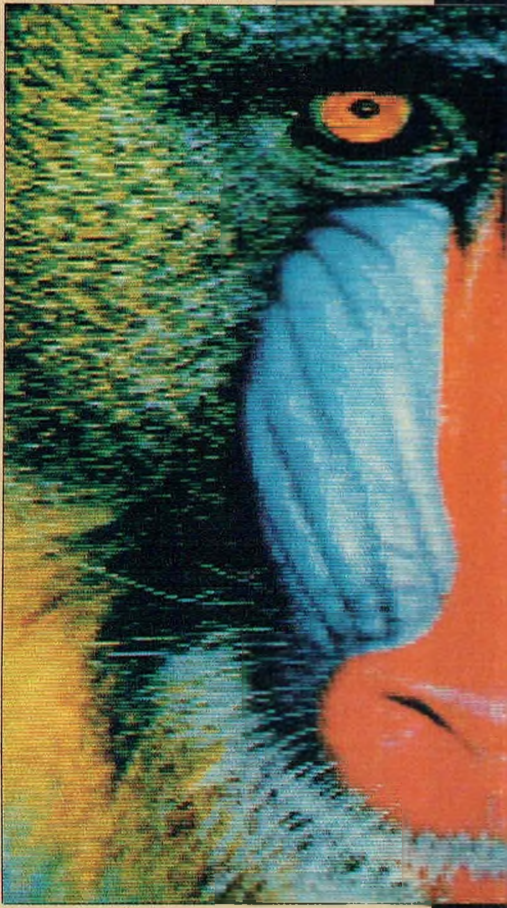


Figure C-9. *NAPLPS (courtesy of In Time Design Studio)*



↑ **Figure C-11.** *NAPLPS (courtesy of Digital Equipment Corp.)*

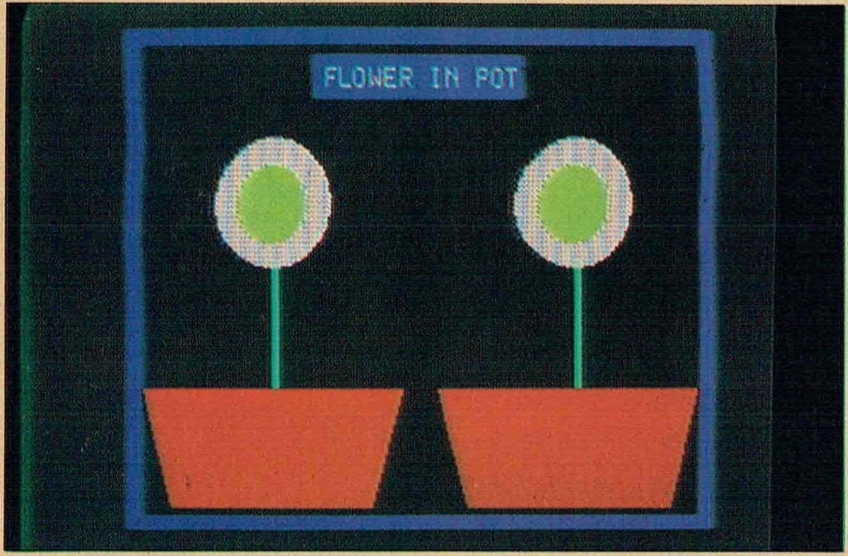
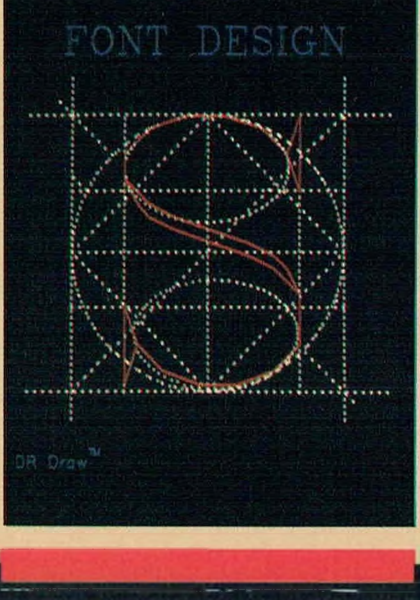


Figure C-10. *NAPLPS (courtesy of David McCune)*

Figure C-13. *DR DRAW (courtesy of Digital Research, Inc.)* →



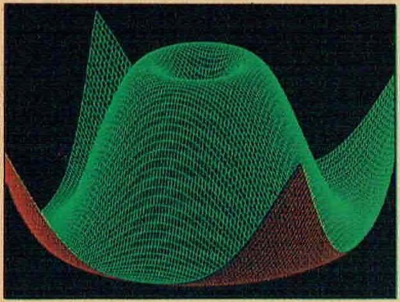


Figure C-12. *High resolution (courtesy of HBO Graphics Lab.)*

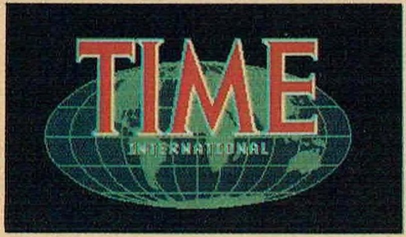


Figure C-14. *NAPLPS (courtesy of Time, Inc.)*

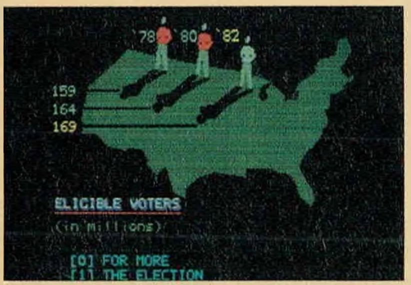
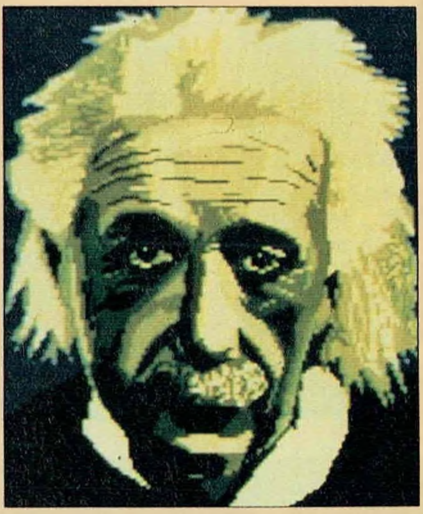


Figure C-15. *NAPLPS (courtesy of In Time Design Studio)*



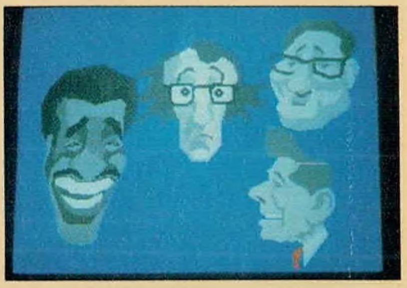
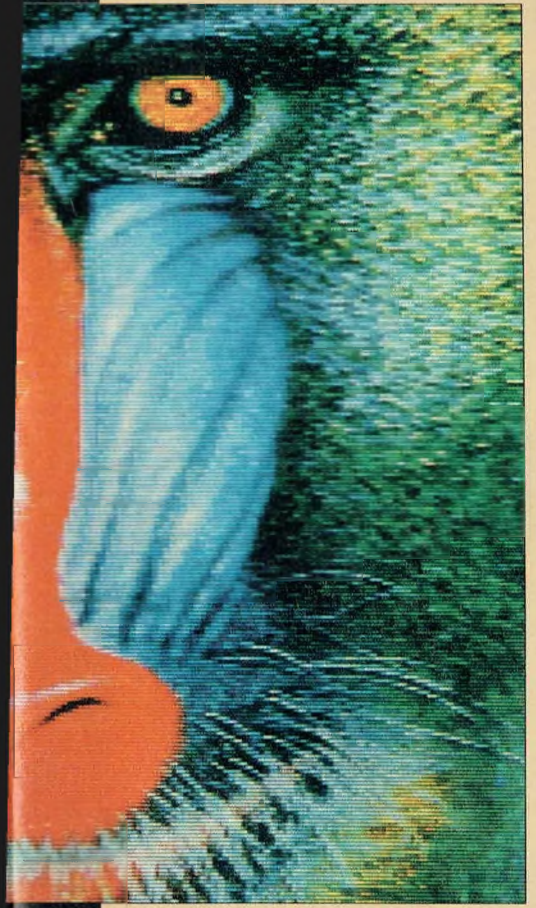


Figure C-17. *NAPLPS (courtesy of The Communication Studio)*

← **Figure C-16.** *NAPLPS (courtesy of HBO Graphics Lab.)*



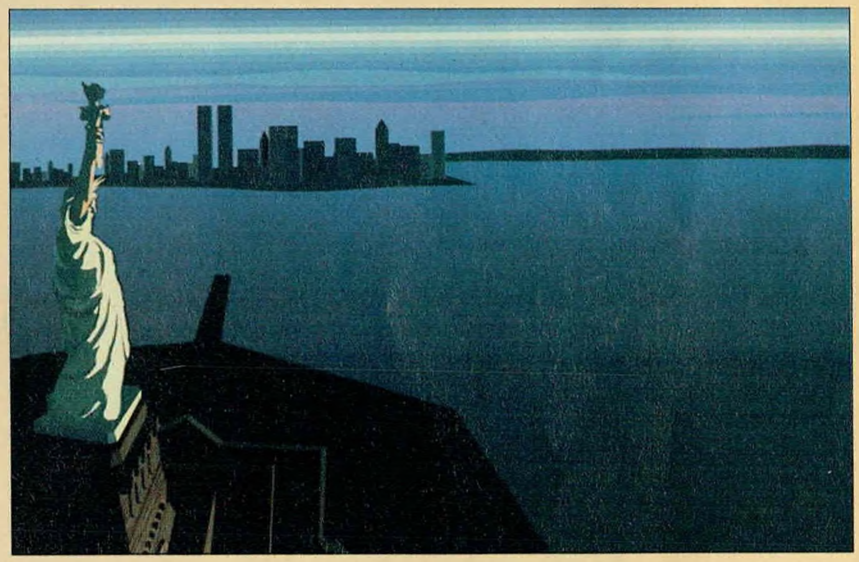
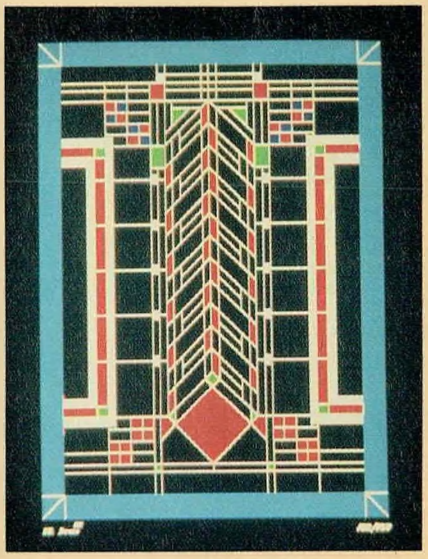


Figure C-18. *High resolution (courtesy of HBO Graphics Lab.)*



← **Figure C-20.** *DR DRAW (courtesy of Digital Research, Inc.)*

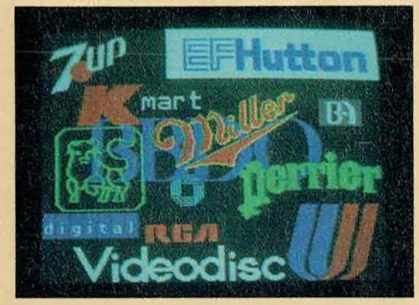


Figure C-19. *NAPLPS (courtesy of The Communication Studio)*

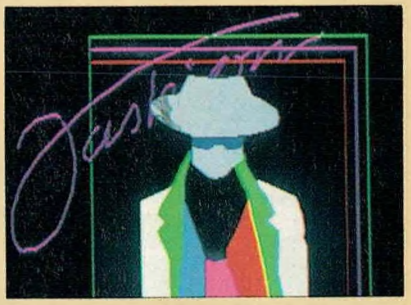
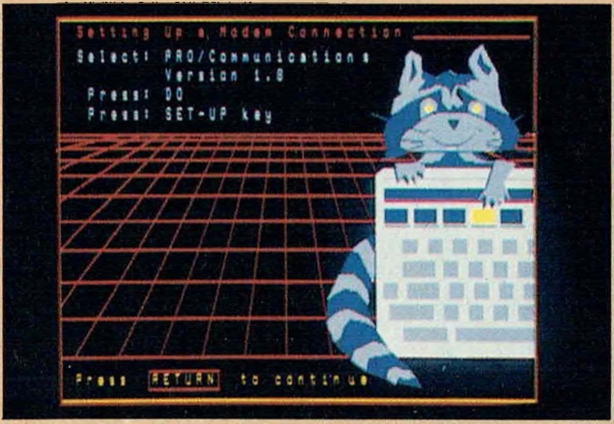


Figure C-21. *NAPLPS (courtesy of In Time Design Studio)*



Setting Up a Modem Connection

Select: PRO/Communications
Version 1.8

Press: DO

Press: SET-UP key

Press RETURN to continue

Figure C-22. *NAPLPS (courtesy of Digital Equipment Corp.)*

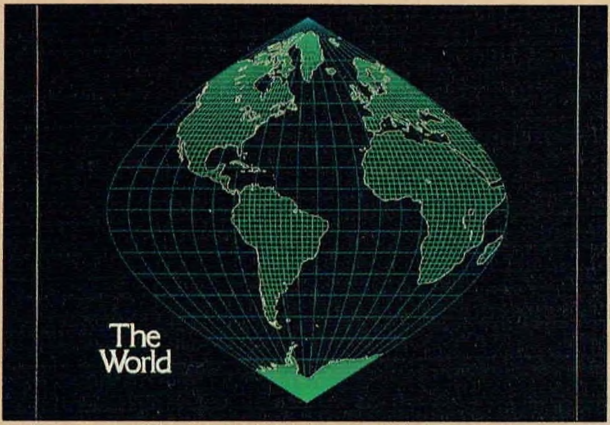
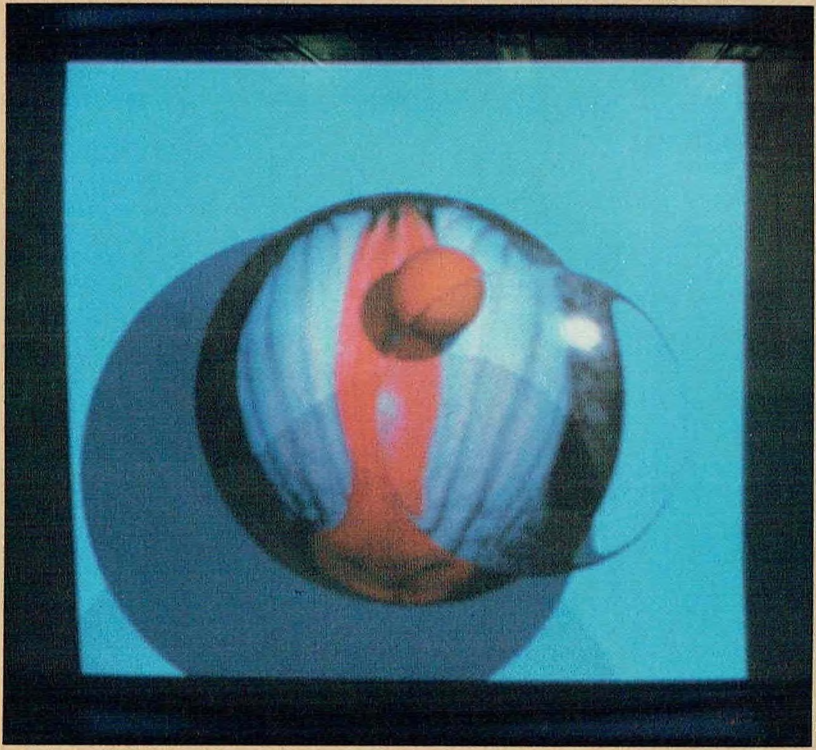


Figure C-23. *High resolution (courtesy of HBO Graphics Lab.)*



← **Figure C-24.** *GIDIS (courtesy of Digital Equipment Corp.)*

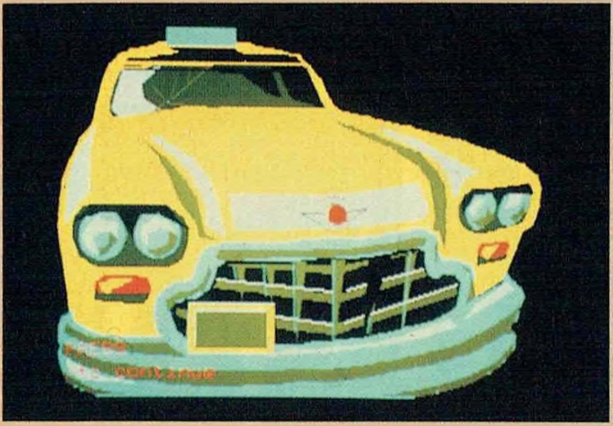


Figure C-25. *NAPLPS (courtesy of The Communication Studio)*

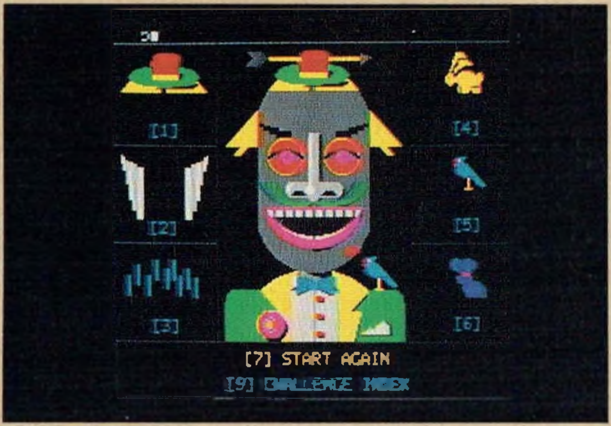


Figure C-26. *NAPLPS (courtesy of Time Video Information System)*

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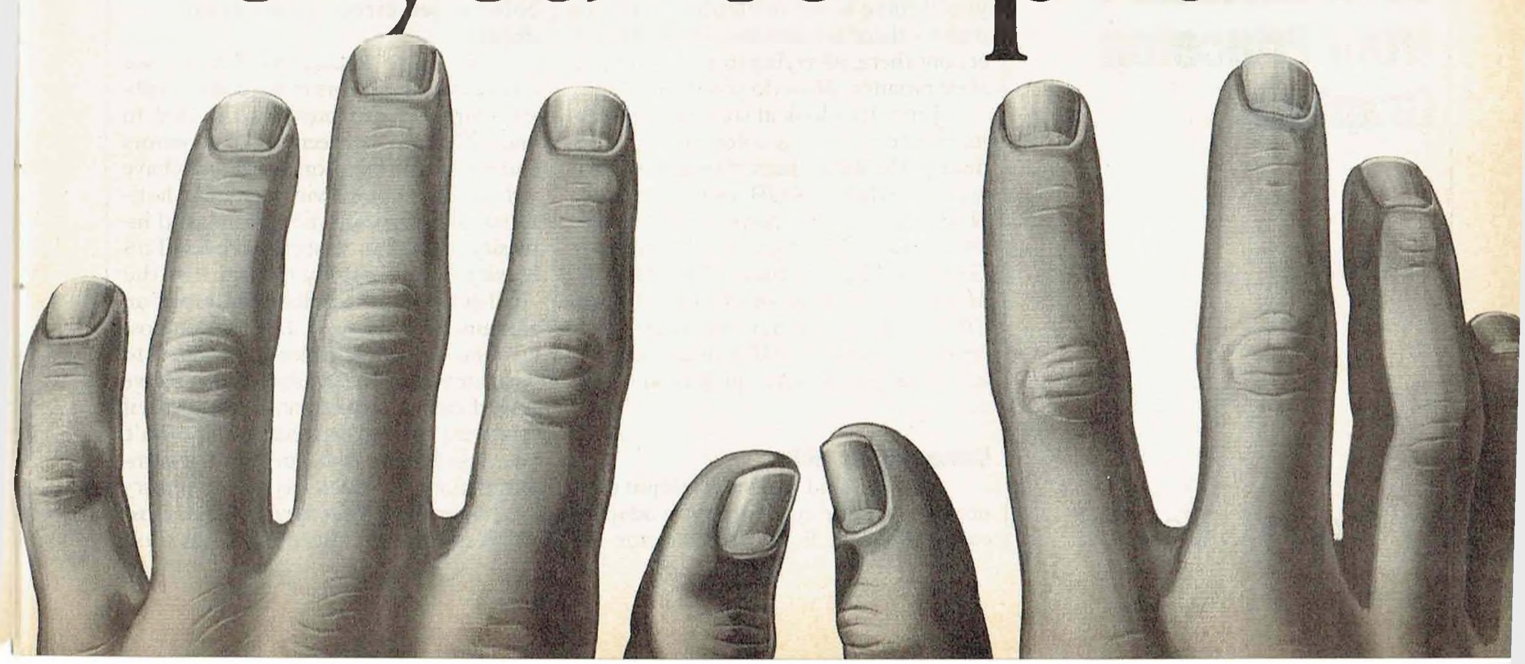

Better Color with the Princeton Graphics HX-12

Composite vs. RGB video, and a review of the HX-12 color monitor from Princeton Graphics

by Andrew L. Bender

If you bought an IBM PC with a color graphics adaptor card and a monochrome display, you probably won't be happy with it very long for two reasons: First, you don't get enough resolution to make prolonged use of the display pleasant; second, you don't get color—and color helps relieve boredom. When you decide to go for a color monitor, you'll have some difficult choices to make—there are dozens of manufacturers out there, all trying to get you to buy *their* monitor. How do you decide?

First, let's look at some of the technical principles of a color monitor and discuss the differences between the two types available: RGB and composite. (*Editor's note: For further information on display technology, see* "Computer Graphics Technologies" *by Alan P. Matthews elsewhere in this issue.*) Then I'll describe a monitor that is an exact replacement for the IBM color monitor, but gives you a better picture at lower cost.

Composite vs. RGB

You will find two video output connectors on your color graphics adaptor card. One is a 9-pin D-connector for connection of an RGB monitor; this has separate pins for red video, green video, horizontal sync, vertical sync, and intensity. The other is a coaxial RCA phono plug for connection of a composite monitor; the six signals that are available separately on the D-connector are electronically blended into a single *composite* waveform that appears at the coaxial connector and can be carried over the single conductor (and shield) of a coaxial cable. Special circuitry in the monitor must separate the six signals again and route them to the sync and color video circuits that create the display.

The above description of the signals on the two connectors of the color graphics adaptor board provides the clue to one difference between RGB monitors and composite monitors: both types have red, green, and blue video circuits, horizontal and vertical sync circuits, and intensity circuits to control the overall intensity of the display (rather like the "half-brightness" emphasis feature of an alphanumeric display). But the composite monitor has additional circuitry to separate the individual signals that arrive lended on the coaxial cable. However, if you read the advertisements, it won't take you long to find out that the composite monitor, which has more circuitry in it, is generally less expensive than most RGB monitors. There is no paradox here: the answer is that the RGB monitor, designed for high-resolution displays, must handle a larger number of smaller dots. This, in turn, requires greater bandwidths (obtained by more careful design with a better grade of components) and more precise control of the phosphor granule size, beam focusing, and color mask accuracy. All of these contribute to the greater cost of RGB monitors.

How sharp the image is depends upon the geometry of the picture tube, its face and phosphors, the stability of the high-voltage power supply that accelerates and focuses the image, and the diameter of the electron beam when it strikes the phosphor. Imperfections in the deflection yoke can result in poor focus in one direction only *(astigmatism)*. If the image is clear in the center but goes fuzzy or changes color at the edges, there may be too much spread in the dots produced by the red, green and blue electron guns *(misconvergence)*. This usually indicates a problem with the deflection yoke or picture tube.

No matter how perfect the tube itself and its associated raster-generating circuits may be, the image will not be sharp if the video amplifiers are incapable of turning the beam cleanly on and off at the beginning and end of each pixel. Thus the number of pixels per second that the monitor can handle is a function of bandwidth, and in practice is approximately twice the bandwidth.

A good-quality television set has a bandwidth of about 3 MHz and can handle about 6 million pixels per second; an 18 MHz monitor can handle about 36 million pixels per second—six times the amount of information, with a resulting increase in detail and sharpness of the image. The overall bandwidth is affected by the amount of circuitry in the individual signal paths; thus the effect of inserting blending circuitry (on the display card) and separation circuitry (in the monitor) into the signal path is to reduce the overall bandwidth, making it impossible to take full advantage of the capabilities of a high-quality RGB monitor. In practice, however, most RGB monitors include separation circuits and a composite signal input connector (as well as the direct RGB inputs) so that they can be used with any kind of display generator.

An alternative to the IBM color monitor

IBM's color monitor is an RGB monitor made by Samsung, a Korean company. The pixels are large (0.43 mm) and therefore somewhat fuzzy. The tube seems to suffer from a moderate amount of misconvergence and astigmatism, especially toward the edges of the picture. The list price of this unit makes it the worst buy of all the available RGB monitors. Of course, if you want the reassurance of having Big Blue service it, then go ahead—but you will pay for this not only in money but in terms of picture quality.

An alternative is the Princeton Graphics Systems color monitor model HX-12. PGS has been supplying this monitor for some time, and it is a mature product. It is made in Taiwan, and doesn't attempt to look like the Big Blue monitor. The picture tube has the same 12" diagonal measurement as the IBM, but pixel size is only 0.31 mm, making the resolution 18% better than that of the IBM. The monitor is about 11" high and 15" wide. To keep the rear ventilation grill clear and allow space the cables, the workspace depth should be at least 18", though the case itself is no more than 14" deep.

> **Most RGB monitors include separation circuits and a composite signal input connector, usable with any kind of display generator.**

There are no fans or other noisy components, though if you have a keen ear you may hear a slight whine from the 15,750-Hz horizontal deflection circuits. The monitor is UL-listed and requires 67 watts of 115 VAC power. Like the IBM monitor, it requires no adjustment or control settings to get it going. It comes with a 61 AC power cord and a signal cable to connect it to the RGB 9-pin D connector on the color graphics adaptor card. In a word, you set it on top of your PC, plug it into the wall outlet and the color graphics card, and you are ready to go.

There are only two controls on the front of the monitor: a pull switch to turn on AC power and brightness control for overall image brightness. Horizontal and vertical hold controls are provided at the rear, but I never needed to adjust these. As a child of the early S-100 world, I am always amazed if a complex product works well when I first turn it on. There it was, set up and working in less than 3 minutes—it took longer just to open the box!

Using the PGS HX-12 with the PC, you can theoretically put 640 dots across the width of the screen (x-axis) and 200 points up the height of the screen (y-axis); the monitor has sufficient resolution to display this with ease. The colors display very well with the PC demo program COLORBAR. It does, however, require a little experimentation to adjust the brightness control for the correct display of gray. If the brightness control is too high, gray looks more like white; if too low, gray is almost black. But once you have found the correct brightness setting for gray, the control need not be adjusted again.

A minor modification of the IBM color graphics adaptor card gives some improvement of quality when displaying text: just add a jumper between the two pads labeled "J3," located at the lower left corner of the 6845 display controller chip. This causes the color graphics adaptor to select the third of the four 2K banks in the character generator ROM.

The first two banks are for the monochrome display, which uses 4K to define a single set of characters. The other two are for the color display: bank 3 defines a single-dot set of characters; bank 4 defines a double-dot font suitable for composite monitors. The addition of the jumper forces selection of bank 3 (the single-dot font) intended for high-resolution RGB monitors. I made this modification and was pleased with the results, though it might not appeal to everyone. (*Caution: If you don't have any experience in working on PC boards, don't attempt to do it yourself. Get a careful and experienced friend to solder the jumper for you.*)

If you have a high-resolution color display card (one that extends beyond the IBM PC color display memory space) you can use it to great advantages with your PGS HX-12. Such cards—of which the Tecmar PC-Mate is one example—display the same number of pixels but in more colors: the PC-Mate can display 16 colors with two screens. Unfortunately, a display of this kind is not IBM PC-compatible. *C'est la vie!*

Summary

The HX-12 RGB color monitor from Princeton Graphics Systems is a plug-compatible replacement for the IBM color monitor that gives better image quality at a comparable price (the

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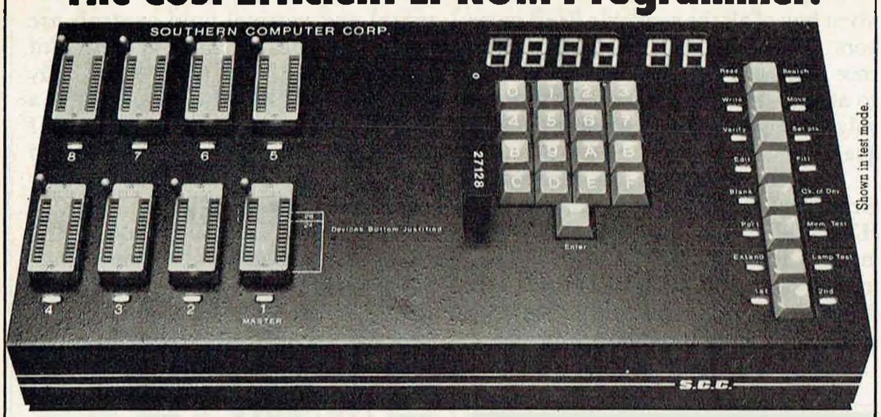

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Continued from page 107

IBM color monitor lists at $680, while the suggested retail price for the Princeton Graphics monitor is $695). It can be remove from the box, set up to run, and placed in service in 3 minutes. The unit is convection cooled and therefore silent; the horizontal deflection circuits are quiet. The unit is well packaged, with a minimum number of controls; the black matrix picture tube has a 0.31 mm dot pitch and will be replaced, if defective, within one year of purchase. There is a 90-day parts and labor warranty.

I consider the PGS HX-12 a "best buy" for a user who desires a high-resolution color graphics display at a moderate price. The careful shopper can purchase this unit for considerably less than the list price of $695.

For more information contact:
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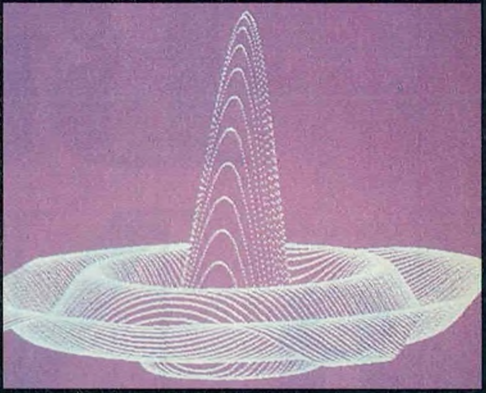

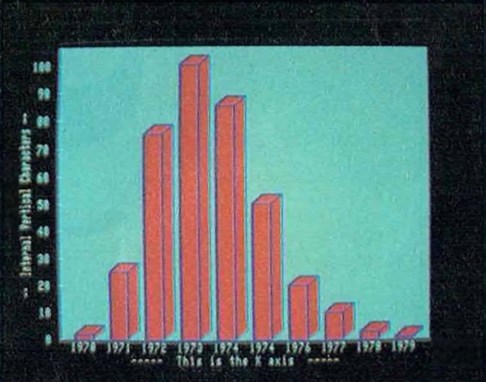

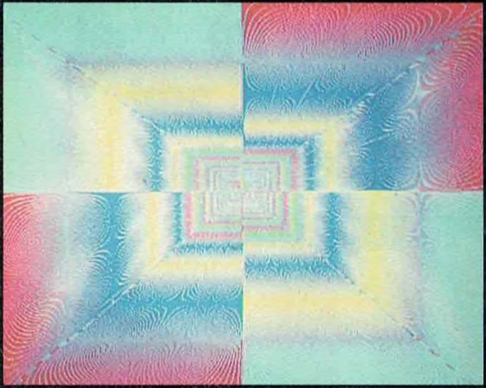

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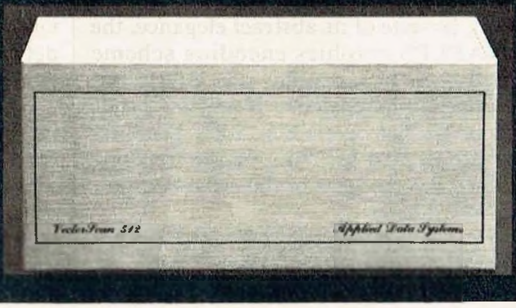

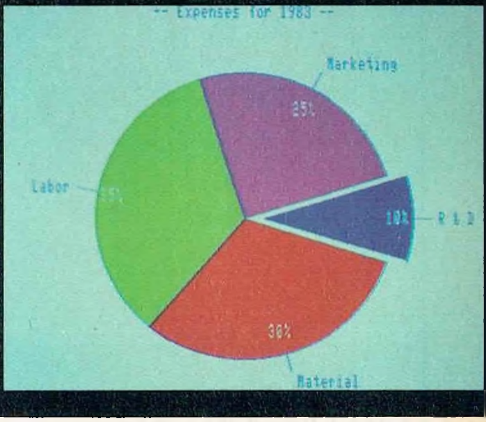

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by Dave McCune

Graphics programming is an exercise in illusion, a kind of noble chicanery. The programmer deals in sequences of bytes, small elements of opcodes and operands. The artist deals in colors and shapes and cursors. The programmer's job is to maintain the artist's illusion that reality consists of graphics, fields of lights which are moved and modified. In fact, of course, the programmer's reality is a world of data structures, shuffled and reorganized and initialized and filled. Only after the programmer constructs the reality of raw data can the artist's illusion be created.

In spite of its abstract elegance, the NAPLPS graphics encoding scheme will never be a popular standard unless concrete, inexpensive NAPLPS products become available. Such products are just now arriving in the marketplace, by-products of the microcomputer revolution.

These micro-based NAPLPS products fall into three general categories. Interpreters transform encoded NAPLPS bytes into video images. Graphics creation workstations produce NAPLPS code. And database management products organize the graphics for display.

We will look closely here at one product from each category. The three components chosen for review all work with the IBM-PC and together form an integrated, desktop NAPLPS development station.

Quickpel

The computer graphics display process consists of three parts (Figure 1). In the NAPLPS context, the leftmost box represents data bytes encoded according to the standard, while the right-most box represents graphic images. All software and hardware necessary to translate the data bytes into graphic images is contained in the middle box. One of the strengths of NAPLPS is its device independence, i.e., the fact that it does not explicitly define the actual hardware and software which comprise the data translator.

Some hardware requirements are implicit in the standard, e.g., the need for a color video monitor and a certain amount of RAM to store definitions of macros and user-defined characters. However, in general, NAPLPS treats the data translation software and hardware as a conceptual "black box," which is usually referred to as a

NAPLPS decoder.

Although a NAPLPS decoder encompasses all of the pieces shown within the blue area of Figure 1, the illustration describes not only a NAPLPS decoder, but hardware presently used in home or office microcomputers. Indeed, the most important trend in NAPLPS decoders today is away from standalone decoders and toward interpreters that run on pre-existing microcomputers.

There are serious problems in implementing a NAPLPS decoder on a microcomputer. Few existing micros have video hardware sophisticated enough to handle the 16 simultaneous color-mapped colors required by the NAPLPS standard. For example, the IBM PC with an IBM graphics board can display only four simultaneous colors in medium-resolution mode. Most existing software-only NAPLPS interpreters for micros, therefore, support only a subset of the full standard.

On the IBM PC, then, full NAPLPS can be accomplished only with the addition of non-IBM video hardware. This can take two forms. First, the NAPLPS interpreter may run on the PC's 8088, using the computer's RAM and communications interfaces. In this case, the interpreter creates its video images on a non-IBM color adapter, such as one of the new color-mapped boards. Another solution, used on the Quickpel decoder, is to put the interpreter in ROM on a plug-in circuit board along with customized video circuitry, RAM, and even a dedicated microprocessor.

In terms of Figure 2, the Quickpel decoder board contains a dedicated microprocessor (an 8088); 80K bytes of interpreter ROM; 16K bytes of program executive ROM; 32K bytes of scratchpad RAM (24K for the NAPLPS interpreter and 8K for the executive that runs the board); 26K bytes of video RAM in a 256 x 210 x 4 bitmap; 6K bytes of RAM for internal NAPLPS storage (macros, DRCS, etc.); 16K bytes of RAM for user programs; a 6845 CRT controller; and video circuitry to produce NTSC composite video. Quickpel communicates with the outside world via the PC bus and a device driver included in the software that comes with the board.

The on-board 8088 is not dedicated to NAPLPS interpretation. In fact, it runs the interpreter merely as one task under the control of a ROM-resident, multitasking executive. Other programs can also be executed. In the videotex world, such programs are called "telesoftware" and can be intermingled with NAPLPS graphics. Since the color map and the entire video RAM are addressable from the processor, Quickpel telesoftware programs can save, modify, and restore any portion of the bitmap. Since this type of bitmap manipulation is impossible from within NAPLPS, Quickpel offers some intriguing opportunities (and pitfalls).

The programmer's job is to maintain the artist's illusion that reality consists of graphics.

Quickpel is currently being marketed only to OEMs. The documentation is not suitable for non-technical users, although installation is not very difficult, since the board plugs into a PC expansion slot. The board communicates on the bus via addresses 380h to 383h and 8380h to 8383h. (Note that IBM has reserved bus addresses 380h to 38Ch for the Synchronous Data Link Control communications adapter and 380h to 389h for the secondary Binary Synchronous Communications adapter, so Quickpel will conflict with either of these two options. Users will be able to change bus addresses on future versions of the board with a wire-wrap tool.) Quickpel also uses hardware interrupt line 2 (now marked "reserved" by IBM) and software interrupt 66, so other conflicts could also arise.

Besides the Quickpel hardware, a device driver called QPEL must also be installed. Once this is done, data can be passed to Quickpel in much the same way as any other MS-DOS device. You can use the COPY command, DOS I/O redirection, or interface routines supplied with the board for access from Basic, C, or assembler.

In its default state, all data received by Quickpel is passed to the NAPLPS interpreter task. This interpreter is simply the best, most complete, most accurate NAPLPS interpreter I have used. Because of the dedicated 8088, it is also very fast, and NAPLPS graphics display more quickly than on most other decoders. This decoder (or its standalone cousin, the EGT-100 by Electrohome Electronics) should be the NAPLPS interpreter of choice in any good NAPLPS development workstation.

An appendix to the NAPLPS ANSI specification describes the minimum performance requirements of any would-be NAPLPS terminal. Quickpel's manufacturers claim that the interpreter meets or exceeds all requirements of this NAPLPS "Service Reference Model" (SRM). I pumped hundreds of NAPLPS screens through the board, and every one performed as required by the spec. All color manipulations and geometric primitives worked well. More complex functions such as odd-sized and rotated character cells; various text paths; horizontal and vertical scrolling; macros; user-defined texture masks; dynamically redefined character cells; mosaics; and so on, all worked fine.

As an aid to systematic evaluation of the NAPLPS repertoire, the Canadian Department of Communications has

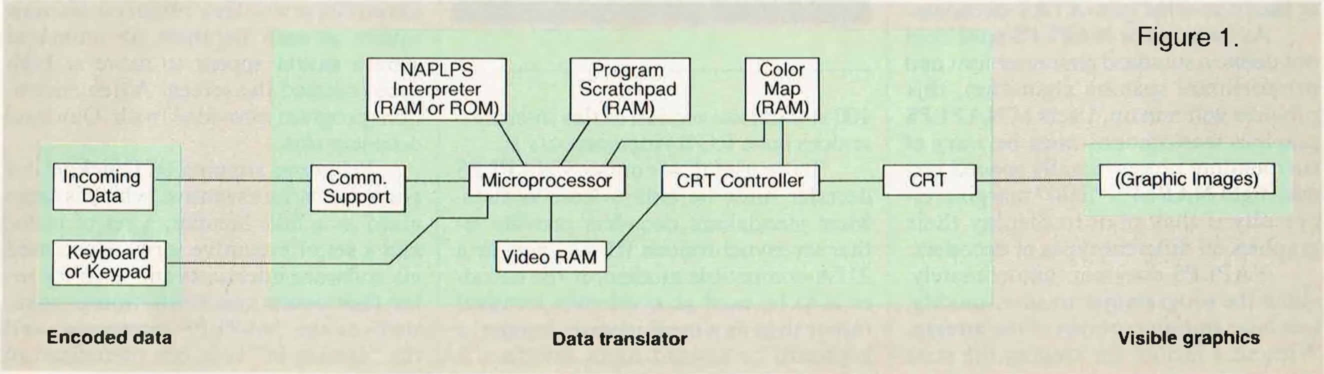


Figure 1.

Build a NAPLPS

Continued from page 111

recently released a package of 270 NAPLPS test frames, each of which is delivered on computer tape or disk, along with documentation and a photographic slide describing its proper appearance. The entire test package is available for $2,200 (Canadian dollars) from *The Canadian Advanced Technology Association, 275 Slater St., # 803, Standard Life Building, Ottawa, Ontario, Canada K1P 5H9.*

As mentioned in the NAPLPS introduction, the spec does not define the font to be used by any decoder for text characters, but only requires that every character fit within the boundaries of the character cell defined by the user. Thus, if a user defines the character cell size to be 1/40 of the screen width, then all character cells on a line will have the same width, regardless of what characters are in the cell, and different decoders will all create character cells of the same width.

However, the shape of the character—for example, the width of the vertical stem of an "i"—may vary from decoder to decoder. This can cause a problem if the NAPLPS proportional spacing feature is used, since the algorithm to determine the width assigned to each proportionally spaced character is left undefined by NAPLPS. As a result, two different decoders may place different numbers of proportionally spaced characters on lines of equal length, and yet both decoders are correctly called "full NAPLPS" decoders!

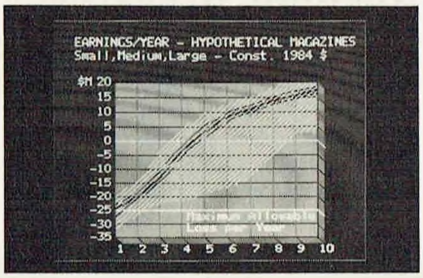
When artists create graphics on the AT&T Frame Creation System, they use a built-in AT&T NAPLPS decoder to display their work. Whenever this graphics workstation places text strings into a graphic display, it encloses the text in a NAPLPS "field," an invisible box which defines vertical and horizontal margins. Since a field defines the length of a line of text, and since various decoders put different amounts of proportionally spaced text on each line, text input into fields on the AT&T FCS often displays incorrectly (or differently, at least) on other non-AT&T decoders.

As long as the NAPLPS spec does not define a standard character font and proportional spacing algorithm, this problem will remain. Users of NAPLPS graphics workstations must be wary of surrounding proportionally spaced text with tight NAPLPS "field" margins, especially if they plan to display their graphics on different types of decoders.

NAPLPS does not, unfortunately, allow the programmer to save, modify, and later restore portions of the bitmap. Without a facility for reading the state of video memory, the NAPLPS programmer cannot make realtime determinations of the color of particular pixels in the display, and thus high-speed bitmap animation is not possible. Further, a programmer has no way of saving the states of a color map for later restoration after a NAPLPS macro is finished. These limitations have led some programmers to dismiss NAPLPS as a general-purpose graphics tool.

Quickpel's telesoftware capabilities can be a wonderful toy.

Quickpel's video output is poorer than on most NAPLPS decoders. No RGB color is available, although it may be on the next version, due to be released soon. The NTSC composite video signal is very good, but some color "bleeding" does occur, and the colors are a bit faded. This is not a problem if the board is used mainly as a display terminal, but it can be hard on an artist's eyes if Quickpel is used as part of a graphics creation package. (The EGT-100 standalone version of this interpreter does have RGB video outputs.)



To be useful, of course, a NAPLPS decoder must be able to receive data. Most standalone decoders provide either an asynchronous RS-232 port or a 212A-compatible modem. If the decoder is to be used as a videotex terminal rather than as a mere passive decoder, a keyboard or keypad input interface is also necessary.

Since Quickpel receives all its data from the PC's bus, the user has a wide range of communications options; in principle, any device that can put data onto the PC bus can communicate with Quickpel.

The user must write the communications interface between whatever communications devices are available and the Quickpel. The only exception is a simple Quickpel/async port/keyboard software interface supplied with the board. This program, VTX, receives data from either of the PC async ports (COM1: or COM2:) and passes it to Quickpel. Data from the keyboard exits through the communications port. Unfortunately, VTX is not as sophisticated as the communications handlers provided with some software-decoders for the PC. It cannot, for example, capture incoming data to a disk file. And it cannot store telephone numbers, logon command strings, and so on for different videotex services.

Nevertheless, VTX is a useful pedagogical object. It runs as compiled Basic, and source is provided. It demonstrates the Basic QPEL device driver interface, an assembler routine which is BLOADed into Basic and accessed by the CALL statement.

In addition to the Basic I/O functions, Quickpel comes with a library of device I/O functions callable from Lattice C and 8088 assembler. Any programmer dissatisfied with VTX should have no trouble writing a more sophisticated videotex handler for Quickpel.

Quickpel can execute programs other than the NAPLPS interpreter on its dedicated 8088. These programs can occupy up to 16K bytes of RAM and have read/write access to all RAM on the board, including video RAM, the color map, and the interpreter's scratchpad. It is perfectly reasonable, for example, to execute a program on Quickpel which will store a small, square section of the bitmap into non-video RAM, replace that square in the bitmap with a new color, and then restore the original colors. If the program were to repeat this process, moving the location of the saved/overwritten/restored bitmap square at each iteration, an animated square would appear to move at high speed around the screen. A demonstration program provided with Quickpel does just this.

Programs running on Quickpel are governed by an executive, which is organized as a task handler, a set of tasks, and a set of executive services accessed via software interrupts and used for inter-task communication. Some tasks, such as the NAPLPS interpreter and the "session-in" task, are predefined in

ROM. Session-in reads incoming bytes and parses session-level commands. In most cases, session-in passes bytes to the NAPLPS task, which in turn writes to video RAM. But incoming bytes may be preceded by session-level bytes indicating that the following data stream is telesoftware. In that case, session-in will load the bytes into program RAM and then pass control to the program.

Since Quickpel is a true coprocessor with respect to the PC, once a telesoftware program is loaded and started, it is entirely independent of the PC. The animation loop mentioned above will continue, regardless of what other programs are run on the PC's 8088.

Programmers can use the PC as a telesoftware development station, of course, and Quickpel comes with assembler and Lattice C software support. For assembler, this includes equates and macros used to make Quickpel executive calls. The C package includes a new C root and a library of C callable functions to perform I/O between a telesoftware program, the NAPLPS task and the keyboard channel.

C programs can be compiled on the PC and linked, using the Quickpel C root and library. Since C I/O functions require DOS, and since DOS does not exist on Quickpel, it is important that no C I/O functions be called. All I/O must use Quickpel library functions.

Once linked, a Quickpel program must be converted to .COM format before being loaded onto the board with a supplied loader.

Quickpel's telesoftware capabilities can be a wonderful toy, of course, and can provide a real sense of liberation to the NAPLPS graphics programmer. But caution is in order. Telesoftware is not standardized. Any program you write to run on Quickpel is almost guaranteed not to work on any other decoder (except the EGT-100, on which Quickpel is based). Nothing compels other decoder manufacturers to use the 8088. And even if they do (as do manufacturers of purely software-based decoders for the IBM PC), the programming environment on these decoders is not likely to match that of the Quickpel.

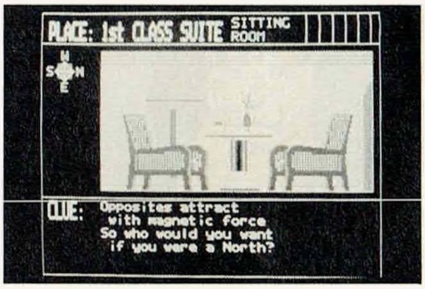
In addition to the non-standard telesoftware, even the session level used to switch back and forth between binary data, ASCII data, 8-bit NAPLPS, 7-bit NAPLPS and other modes is non-standard. Applications programmers and videotex system operators must provide session-level handlers for every possible decoder. Likewise, decoder manufacturers must include session-level handlers for all current videotex systems and other NAPLPS applications.

The whole point of NAPLPS is that it is a standard. As soon as we use Quickpel's telesoftware features, we give up the advantages of a standard. NAPLPS is somewhat limiting, to be sure, and programmers need the freedom provided by telesoftware. However, this does not mean that each decoder manufacturer should develop a unique telesoftware implementation. Instead, we should recognize that the time has come to extend the NAPLPS standard to include telesoftware functions. In fact, ANSI is currently considering a telesoftware extension to NAPLPS. This extension, called Tcode, includes opcodes for traditional programming facilities such as flow control, variable handling, and parameter passing, encoded as a G set.

Createx lumps NAPLPS commands together in superentities called "elements."

Createx-C

The most primitive conceivable NAPLPS graphics creation system is a simple text editor into which we input byte after byte of raw NAPLPS code. The editor also allows the code to be passed to the interpreter for viewing and subsequent modification.



Opposites attract
with magnetic force
So who would you want
if you were a North?

At a slightly higher level of abstraction, there might be a "symbolic assembler" that could interpret symbolic names assigned to each NAPLPS opcode (e.g., "SLA" for "Set and Line (Absolute)," opcode 2Ah). Operand formats could be defined so that coordinate data, for example, could be entered as decimal numbers. The display process now has two steps: the conversion of symbolic opcodes and operands into raw NAPLPS opcodes, and the transmission of these to the interpreter.

Since certain opcodes often appear together in groups, each recurrent group could be given a symbolic name and be defined as a "text entity." This new entity takes a series of arguments, and is treated rather like a subroutine or function in a high-level programming language. The data we enter into our NAPLPS editor now bears little resemblance to the final data sent to the interpreter. By grouping NAPLPS opcodes into high-level super-opcodes, we have more closely approximated the artist's abstract world.

Finally, the text editor itself becomes superfluous. Instead, a menu of graphics choices is displayed on one part of the screen. The artist moves a cursor from choice to choice: with each selection, an appropriate shape appears on the screen. The artist no longer sees the textual representations of superentities. To delete a circle, he might move the cursor onto the circle and press a "delete" key. All the translation—from shape on the screen, to superentity, to individual NAPLPS opcodes and back to interpreted graphic—occurs instantly and entirely behind the scenes.

Createx-C, a new NAPLPS creation system, provides this high-level interface without entirely hiding the underlying nature of NAPLPS from the artist.

Createx-C runs on the IBM PC and on a DEC 11/03 under RT-11; CP/M and UNIX versions are planned for the future). Createx does not use the PC's color graphics capabilities, but requires a separate NAPLPS decoder (either a Quickpel board or a standalone decoder connected to COM1:) and a color monitor. At present, the Quickpel version is still in a pre-release state and contains many bugs that have been fixed in the production version (which requires an external decoder). This review was based on tests of both versions.

Just two years ago, NAPLPS workstations were expensive, dedicated systems costing many thousands of dollars. Createx is one of a new, less expensive, group of NAPLPS packages. It is software which runs on off-the-shelf micros, requiring only the addition of a NAPLPS decoder and color monitor. The fully configured Createx system I used for this review cost less than $6,000 ($2995 for a Compaq, $800 for a composite color monitor, $625 for a Quickpel decoder and $1450 for the Createx software.) At less than 20% of the cost

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of AT&T's Frame Creation system, Createx supports nearly the same range of NAPLPS features.

The manual is nearly as compact as NAPLPS code. The entire documentation package consists of a 67-page typewritten manual. By comparison, the "Picture Painter" NAPLPS creation system by Cableshare, Inc., comes with two volumes of documentation, the first of which is 206 pages. The Createx manual is a good quick-reference guide once you know your way around, but makes a very half-hearted attempt at a tutorial for new users, introducing only a tiny fraction of the many NAPLPS commands. I think you'd be in trouble if you just plopped Createx and its manual down on an inexperienced NAPLPS artist's desk.

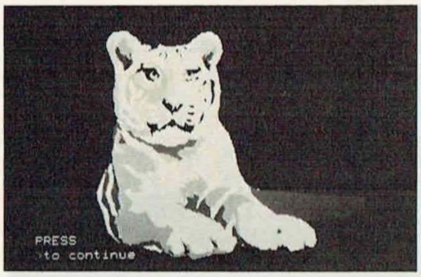
In terms of the four levels of user-interface abstraction described earlier, Createx falls into the second highest level. The AT&T FCS, for example, has an almost entirely graphics-oriented user-interface and tries to hide the internal concepts of NAPLPS from users. It falls squarely into the highest level of abstraction. Cableshare's Picture Painter, on the other hand, is more akin to the "symbolic NAPLPS assembler" described above. It presents the user with individual NAPLPS commands based on actual opcodes. I believe that occasional NAPLPS artists will find the AT&T approach faster to learn and more comfortable. On the other hand, artists trained on the less abstract Picture Painter will probably learn more about how NAPLPS works and will more readily use its complex capabilities such as blink-based animation. The Createx element-oriented approach lies in between the AT&T and Cableshare approaches, and may satisfy both needs. Createx is to NAPLPS what C is to programming.

Createx uses two monitors: the PC's monochrome display for menus, and a color monitor for display of NAPLPS graphics. When Createx starts, the color monitor is blank and the main menu appears. You can choose one of Createx' five modes: Select (to load and store files), Create (to input new graphics), Edit (to modify graphics already created), Define (for creating color palettes) and Macro (for defining a string of NAPLPS commands as a macro).

"Create" mode is the most likely first choice. This is where you enter new NAPLPS code. The basic principle is to select a geometric shape and its attributes from the keyboard according to menu prompts and then to specify the size and location of the shape by moving a cursor on the color monitor with the help of the keyboard's arrow keys.

Createx lumps NAPLPS commands together in a number of super-entities called "elements." In Create mode you string together a series of these elements. A "rectangle" is one element, for example, and to create it you first type "R." This causes the rectangle sub-menu to appear on the monochrome monitor, prompting you for attribute information. You can make the rectangle filled (as opposed to outlined) by typing "F." Other attributes defined from this menu include brush size (line width), drawing color, fill pattern (solid, cross-hatch, etc.), highlight color, and so on. Once you set all these attributes (or simply use the defaults), you use the arrow keys to move a cursor on the color monitor to the desired location of one corner of the new rectangle. You enter the coordinate by hitting the "Ins" key. You then move the cursor to the diagonally opposite corner of the rectangle and hit the "Ins" key again. Bingo! A rectangle pops up on the screen. You have just finished one "element" and can go on to another by typing, say, "A" for arc.

Createx is to NAPLPS what C is to programming.



The Createx user-interface is ideal for frequent users, though beginners will have a little trouble. The menus are brief and a bit cryptic (who could know that Texture Pattern "22" means that the object will be highlighted and filled with horizontal hatching?). There are no on-line help facilities, so until you learn the command structure you will need your manual. Fortunately, it has an index. Once you know the commands, though, Createx is very fast. Many commands require only a single keystroke. And those which require longer numeric input can be terminated by the start of a new command. So you can bang in a long string of commands without stopping to hit the return key. "RFZ2, 2S8T13" defines all the attributes for a filled rectangle using a 2 x 2 pixel brush stroke, drawn with whatever color happens to be in color-slot 8, using a cross-hatch fill pattern. All that is left is to move the cursor around to define the size and location of the rectangle.

Currently, the only way to move the cursor around the color monitor is by means of the keyboard cursor keys. Many computer artists will miss the speed of a tablet with pen or mouse. Such a tablet is actually essential if the artist wants to create pictures by tracing photographs or printed drawings. A corporate logo, for example, is best drawn by placing a printed logo on a tablet and then tracing it with lines and polygons. Support for four different bitpads is scheduled for the next two releases of Createx.

Once you have created some elements, you can edit them. To do this you return to the main menu and choose "Edit." The monochrome screen displays the attributes of the most recently added element. You can use the < and > keys to leaf through the elements one at a time until you get to the one you want to change. You can then change any attribute such as color or texture, or you can erase the element or replace it with a new one.

Createx lets you edit a whole group of elements at once. You might want to move all the elements (rectangles and polygons, say) that make up a house. Instead of moving each element individually, you can define a "group" of elements and then move the entire group.

Oddly enough, Createx has no straightforward way of inserting a new element into a string of elements. Since NAPLPS is processed sequentially by an interpreter, objects build on the screen one after another. This sequential display is used for effect by some artists, and the order in which elements are entered into the NAPLPS string is important. If you want to insert a new element into a string, you have to go through a two-step process. First, you create the new element as the last element in the string. Then you define a group consisting of all the elements you want to come after the new one, and use the "Order" command to switch the order of the new elements and the old group.

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TPL

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Build a NAPLPS

Continued from page 114

At present, Createx provides no means of "scaling" an element, i.e., stretching it along its x- or y-axes. This feature is being added to the next version, which is due to be released by the time you read this.

Many NAPLPS frames consists of graphics with superimposed textual information. The text may need to be updated frequently. Createx excels in its facility for entering and editing NAPLPS text. To start entering text into a frame, you use the " key to define a "text element." You then select attributes such as character rotation, spacing, and so on, along with the starting coordinates for the text string. You press "Ins" to start entering text.

You need to keep your eye on both screens when you deal with text. Each character you enter, including control characters such as tab or carriage return, will be echoed in the text-entry area on the left side of the monochrome screen. At the same time, the text will appear in the proper color and size on the color screen. The Escape key will take you out of text insertion mode and let you change text attributes such as color. If you make a mistake while entering text, the F9 function key puts you in "edit text" mode. You can now move the cursor through the text on your monochrome screen, adding and deleting characters and attributes as you go. The Shift-F9 key ends "edit text" and redisplays the new text on the color monitor.

Two design problems show up during the switch between "Create" and "Text" modes. First, the current version of Createx makes heavy use of programming overlays, so some menu selections result in annoying pauses while new code is loaded from disk. On a floppy-based system, the switch from Create to Text takes 10 seconds. I avoided this problem by loading Createx onto a RAM disk. The next release of Createx should use no overlays, so the problem may disappear.

The second problem results from Createx using the PC's ANSI-compatible screen driver to draw menu screens. Createx is written in C and is designed to be easily portable to other micros. The use of standard ANSI video I/O increases portability, of course, but the ANSI driver is painfully slow when compared to direct video RAM I/O. As I got used to Createx, I often found myself having to wait between commands while the menu screen redrew line by line. A few wasted seconds as menu screens appear may not sound like much until multiplied by the hundreds of menu screen accesses common in a normal production day.

A color palette definition is treated as a separate element by Createx. A palette is defined by choosing "Define" from the main menu. In this mode, a color slot is chosen and then the red, green and blue values are entered from the keyboard for that map entry. Color may also be defined in terms of hue, saturation and luminance. Createx defines red, green and blue values on a scale of 0 to 63, resulting in 262,144 different colors. Most decoders, though, can only differentiate 512 or 4096 colors.

Since NAPLPS uses color-mapped technology, changes in a color slot are instantly reflected on the video display. All objects drawn using, say, color slot 13 instantly change color as a new definition is entered for slot 13. This facility for lightning-fast color changes is commonly used to animate NAPLPS graphics.

Color definition is not as easy as it might be. Cableshare's Picture Painter, for example, also allows the artist to modify a color by moving a pen around a tablet. In this mode, a color gradually changes as the pen is moved, and the artist can quickly adjust a shade until it looks right. Createx forces the artist to type in new numeric values to make any change in a color.

One feature unique to Createx is "autoshade." After you have defined colors for two non-adjacent color slots, Createx can automatically create a range of colors that progresses from the first color to the last. If we define slot 1 to be very dark blue, for example, and slot 15 to be very light blue, autoshade will automatically create an evenly stepped scale of blue shades in slots 2 to 14.

Createx excels in entering and editing NAPLPS text.

Macros are easy to define. You begin by creating one or more elements. Then, after entering one of the two macro modes from the main menu, you select a group of elements that will make up the macro. Createx then prompts for a macro label in the range 32 to 128. From then on, the macro may be invoked by simply including its label as a new element in the frame. Createx does not allow definition of "Transmit Macros," commonly used to define function keys on some NAPLPS videotex decoders.

User-defined texture masks, dynamically redefinable character sets (DRCS) and "incremental PDIs" are not available in the current release, though they are scheduled as part of a June update to Createx.

Videotex is more than hardware: it is also content and presentation.

Once a series of NAPLPS elements has been created and edited, they must be stored as a DOS file. Like many word processors, Createx keeps all changes made during an editing session in RAM. Unless you store it in a file, your work will be lost if you exit from Createx or if your system crashes.

Createx is unfortunately poor at protecting suicidal users from themselves. From the main menu, the @ key exits Createx immediately, with no confirmation prompt. And Control-X clears all memory, again with no confirmation request. So you should be sure you stored your work before you think about leaving Createx. (In one unfortunate bug, the F6 function key, which should have no effect from the main menu, aborts Createx.)

Createx tends to eat up disk space. First, Createx will not allow you to store data into a file that already exists. If you want to edit a NAPLPS file called TEST1, for example, you will have to store the edited version as TEST2 or some other name. Createx will not let you overwrite TEST1, no matter how badly you want to. After a few hours, you are likely to be working on TEST13 or so....

Second, when you store a file, Createx stores it in a non-NAPLPS internal format which contains all the NAPLPS code, along with control information which tells Createx where each element begins. Before a file can be sent to a NAPLPS decoder, it must be "compressed," i.e., all the control information must be stripped. Users must be aware that Createx is unable to edit compressed files. If a file is stored and compressed and the internal format version is deleted, Createx will never be able to modify that file again.

Once Createx' designer decided to force users to deal with internal format files, it is a shame that these files were not used more effectively. One of the nicer features of Picture Painter, for example, is that its internal format files can contain comment lines. NAPLPS files are, after all, programs, and comments which describe macros, DRCS definitions, and so on, can be invaluable for future updates of complex files.

Besides stripping out control and mapping information from the internal file, the compression process also offers a chance to search for and delete inefficient or redundant NAPLPS code. In spite of this compression, Createx still leaves some redundancies (a string of 5 consecutive 0Eh bytes, in one case) in its final code. This type of wasted space is not trivial when multiplied by the tens of thousands of files which make up some large NAPLPS databases.

Examination of Createx output files shows them to contain nothing but proper NAPLPS code. Given this, it would seem at first glance that these files could be retrieved by and edited on any other true NAPLPS workstation. And vice versa. This is not true. It is very unlikely that any complex NAPLPS file from one NAPLPS workstation will be editable on any other NAPLPS workstation.

An example will illustrate the problem. NAPLPS offers several ways to draw a rectangle. One method is to set a drawing point with the "Point Set (Absolute, Invisible)" opcode and then to specify the rectangle with a "Rectangle (Outlined)" opcode. Another method is to combine both of these opcodes in the "Set and Rectangle (Outlined)" opcode. Both methods produce identical graphics (though the latter method is more efficient). It is not likely that a programmer designing a graphics creation system will implement both methods of drawing a rectangle. In order to save time and code, the programmer might, for example, recognize the "Rectangle (Outlined)" opcode and not the "Set and Rectangle (Outlined)" opcode. In that case, the software will stumble if it ever tries to edit a NAPLPS file that contains the latter opcode. An interpreter, of course, must recognize every possible NAPLPS opcode, but graphics creation software can meet artists' needs with only a subset of NAPLPS opcodes.

This problem is becoming serious now that there are a number of competing NAPLPS creation systems. Any production shop which uses more than one NAPLPS system will have to be careful to keep the NAPLPS files from each system separate, at least if those files are ever to be re-edited.

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Build a NAPLPS

Continued from page 117

All in all, I like Createx. It needs better on-line and hard-copy documentation and better safeguards against klutzy users. But with the addition of a graphics tablet interface, a DRCS and texture mask editor, and incremental PDI capabilites, Createx would be ideal. It is relatively inexpensive and runs on a common, versatile micro. In conjunction with a good decoder such as Quickpel, Createx forms a solid piece of a professional NAPLPS workstation.

Videophile

NAPLPS is a creature of videotex. The word "videotex" usually conjures up images of huge, squid-like communications networks, with high-powered host computers that stretch hundreds or thousands of electronic tentacles across continents.

But videotex is more than hardware. It is also content and presentation, an editorial as well as technological medium. Large videotex systems have generated many efficient and exciting new ways of organizing and presenting data to consumers. Menus, keywords and graphics-laden computer screens are becoming as natural a communication medium as printed pages.

Inexpensive micros can bring the advantages of the videotex medium into millions of offices and homes. Software products that utilize the videotex medium on micros are now appearing. These range from small multiuser host systems for display of ads in shopping malls to single-user videotex-like systems used to organize and access anything from business presentations to computer-aided instruction scripts.

Videophile is one of these systems. It is a single-user videotex database management tool which can be used to organize, link and access NAPLPS frames.

The migration of videotex to micros is such a new concept that the few products that do exist must struggle to find a market. The ill-defined market is reflected in incomplete functionality. None of the products, including Videophile, are very sophisticated. But an examination of what Videophile does and does not do will help us understand the potential usefulness of micro-based videotex.

Videophile provides two basic services: it allows a database manager to organize NAPLPS frames into a linked database, and it allows a remote user to access the frames in various ways—"remote" in this sense may mean that the host is no further away than the end of your arm; but the remote user might also communicate with the host PC over a phone line and modem.

A database manager starts by assembling NAPLPS files on a DOS-formatted disk. In the normal case, each file will contain one "screenful" or "frame" of NAPLPS graphics. The database will consists of a group of frames organized in such a way that end-users can move or navigate from frame to frame by typing in commands on the keypad or keyboard of the remote terminal. (The remote terminal is a NAPLPS decoder, either a standalone unit connected to the host's async port or a Quickpel board.) The database manager will assemble the frames into a linked database. Each page in the database will have a unique name and will be associated with one NAPLPS DOS file. In addition, the database manager will specify for each page which keyboard commands will move the user to which other pages.

As an example, a very simple database might consist of three pages named DOGS, SPANIELS and COLLIES. DOGS will be the "root" page, the one that first appears when the system is started. The database manager defines pointers which connect any frame to any other. We might specify, for example, that typing "1" while viewing page DOG will cause SPANIELS to be displayed, while pressing "2" will cause COLLIES to appear. And we could specify that the "^" key from either COLLIES or SPANIELS would cause DOGS to redisplay. Once we have defined these links between pages and associated a particular NAPLPS DOS file with each page name, we have a working NAPLPS database. The remote user can navigate from page to page.

A page may have 20 outbound keys, which can point to any other pages.

Videophile databases are quite easy to create, once you know how to do it. The first time around is tough, though, since the documentation is brief and disjointed, and there is no on-line help. Once you have collected NAPLPS files on a disk, you start up the PAS (Page Access System) module of Videophile and supply a name for the new database. You must also edit a configuration file which specifies whether your remote

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Build a NAPLPS

Continued from page 118

decoder is a Quickpel board or an external decoder connected to an async port. You also specify whether end-user input should come from the PC's keyboard or from the external decoder's keyboard.

You pick the "Define Pages" choice from the main menu. When you do this, the root page for the database (always named "DATABASE") is accessed. Since the database is new and no NAPLPS files have been associated with it, nothing happens on the remote color monitor. On your PC's monitor, though, an icon representing a file folder appears. The folder is labelled with the current page name, i.e., "DATABASE." Sub-headings on the folder list the various "forms" there: Reference, Descendants, Titles, Prompts and Etc. You begin by picking the Reference form, causing it to pop out of the folder and fill your screen with several input fields. This is where you associate a particular NAPLPS DOS file with this page. Once you have done this, you can return the form to the folder. As you do this, the NAPLPS file associated with "DATABASE" is pumped to the decoder. Your database now has one real page.

A new page may be added to the database only after it has been listed as a "descendant" of another page. A descendant page is one which is accessed via some sequence of keystrokes from some other, so-called "parent" page. Descendants of a particular page are defined by picking the "Descendants" form from a page's iconographic file folder. A descendant is defined by a "key" (a 1-6 character command) which points to a target page. COLLIES was a descendant of DOGS in our earlier example. Once a new page has been defined as a descendant, it can be accessed. In order to complete the definition of a page, you must first access it. Again, since the new page has no associated NAPLPS file, nothing will happen on the color monitor. But the file folder for the new page will appear on the PC monitor, and you can choose the Reference form to complete the definition of the new page. This new page may in turn have its own descendants, which in turn will have their own descendants and so on.

Videophile databases are easy to create, once you know how.

Any page can have up to 20 outbound keys, which can point to any other pages. Pages can point to each other, to parent pages, to "siblings" (descendants of the same parent) and so on. As the manual notes, "you can create a simple, tree-structured database; or you can create a rat's nest."

A complex database is not easy to manage. Videophile provides no means for listing, say, all the pages which point into a particular page. Indeed, there is not even any facility for producing a legible list of all the pages in the database. (You can print the database map file, but this ASCII file is organized mainly for PAS to read, not for humans.)

Besides its database access capabilities, Videophile offers a few other noteworthy features. The keystrokes required to execute various navigation

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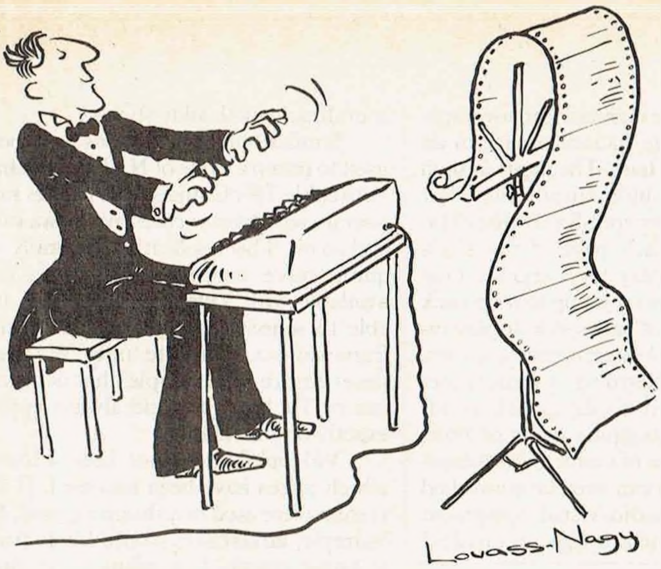

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Build a NAPLPS

Continued from page 120

functions (go to parent page, go to previously accessed page, etc.) can be defined by the user in a configuration file. It is even possible to define whether a user must terminate key entries with a carriage return or other terminator in order for them to take effect.

A separate program in the Videophile package, appropriately named TRESPAS, allows the database manager to log onto other remote databases and capture display data. The captured data can be written to disk files and later incorporated into a Videophile database.

The database manager can use a special kind of key to include a page in an "autosequence" chain. The pages in such a chain display automatically one after another in an order specified by the database manager. Each page in the chain can be set to display for a specific time period. If the chain is set up to loop back on itself, a cycle of pages will display indefinitely, or until interrupted by a user. This type of "billboarding" feature is useful for unattended displays, such as advertisements in shopping malls or hotel lobbies. (By means of Game Card Adapter interface, PAS can even be controlled by the type of audio/visual equipment which synchronizes tape-recorded soundtracks with slide shows.)

Similar billboard systems have been used to pump a cycle of NAPLPS frames onto cable TV channels. The frames may contain ads, sports scores, news, weather and so on. This application generally requires more accurate timing than that available with Videophile, which is unable to schedule the display of specific frames at exact absolute times. We could never ensure, for example, that news stories or TV listings would always appear exactly on the hour.

Videophile does not keep a log of which pages have been accessed. If the system were used in a shopping mall, for example, advertisers would likely want to know exactly how many times their ads had been seen.

Another likely requirement of such systems is remote updating. For systems in public places, it would be convenient if the database operator could add and delete pages and files without having to visit the machine. One operator might service scores of miniature videotex systems in a local area, and updates via phone lines would be very efficient.

Even without these features, Videophile is a useful addition to our NAPLPS development station. The organized presentation of graphics to end users is, after all, what makes NAPLPS useful, rather than just interesting.

Quickpel

Network Videotex Systems, Inc., *235 Yorkland Blvd., #300, Willowdale, Ontario, Canada M2J 4Y8; (416) 492-9803.*

Price: $625. **System requirements:** IBM-PC, 96K RAM, composite color monitor.

CIRCLE 311 ON READER SERVICE CARD

Createx-C

TVOntario, *2180 Yonge Street, Toronto, Ontario, Canada M4T 2T1; (416) 484-2613.*

Price: $1,450. **System requirements:** IBM-PC, 128K RAM, NAPLPS decoder (Quickpel or external), composite color monitor (Quickpel), RGB color monitor (external decoder).

CIRCLE 312 ON READER SERVICE CARD

Videophile

Barros & Associates, Ltd., *154 Queen St. South, 112, Streetsville, Ontario, Canada L5M 1K8; (416) 858-1043.*

Price: $850. **System requirements:** IBM-PC, 192K RAM, async port, NAPLPS decoder, color monitor.

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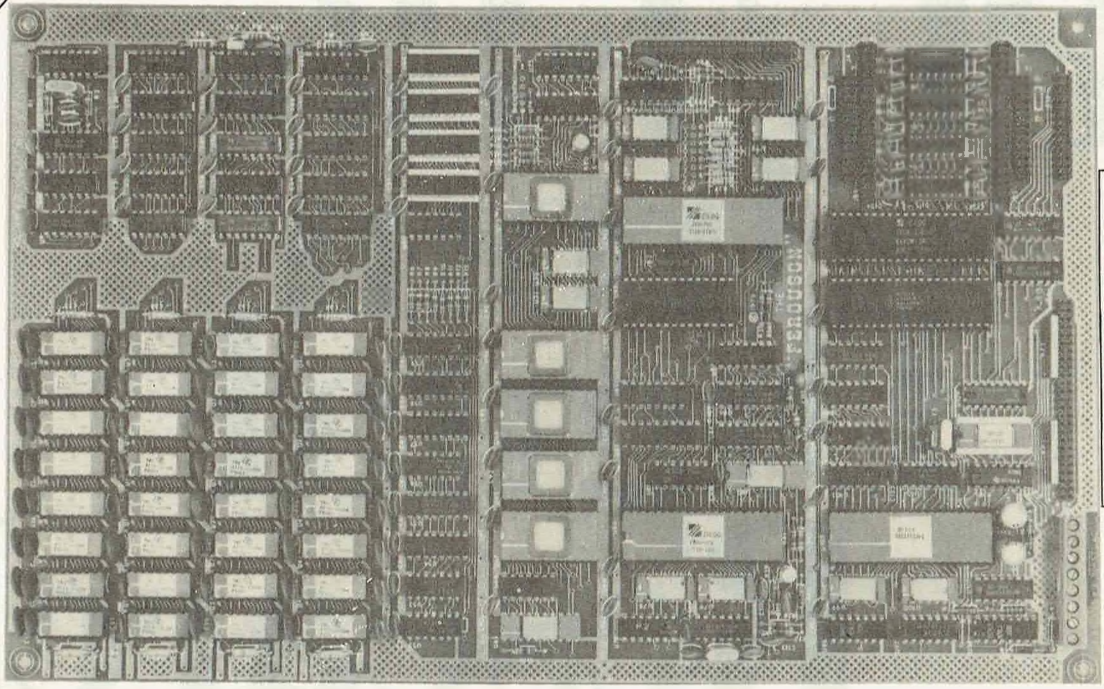

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PL/I-86 from Digital Research

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by Andrew L. Bender

Since I reviewed the PL/I-80 compiler a couple of years ago (*Microsystems,* January 1982), I wanted to review the PL/I-86 compiler when it was announced. This report presents the results of compilation of 12 large to very large PL/I-80 programs and how they moved to PL/I-86. For brevity, "P80" will mean Digital Research's PL/I-80 compiler, and "P86" their PL/I-86 compiler.

I had a very positive experience with P80. I found it easy to use and quite fast (although the LINK80 program was so slow I thought it should be named SNAIL rather than LINK). The generated code was very good, and the library routines were fairly efficient. There were some problems with some of the built-in functions such as BINARY that came to light after my report, but these could be easily programmed around. P86 was the next step. I wanted to get my programs running on my 8088 system as soon as possible. I read a glowing report about how some software outfit moved their 8080 CBasic programs over to the 8086 just by recompiling them on CBasic-86. Well, I can't say that I did that! I found out that P80 and P86 are not exactly the same—but they are close.

Compatibility problems between PL/I-86 and PL/I-80

P80 uses a six-character entry point name, while P86 uses the entire name. A procedure GETANSWER in my 8080 version generated a request for a program GETANS, which was okay except that I called the program GETANS in some places and GETANSWER in others. My fault! I needed to fix those places because P86 knows that there is a difference between a program called GETANS and GETANSWER. In my 8080 programs there were many subroutines that I used over and over (isn't that what relocatable subroutines are all about?), so I just made myself a file full of declarations such that this file could be "%INCLUDEd" in every program written. This .DCL file declared the entry point names of all my subroutines and the parameters of each subroutine or function. This allowed me to reference those subroutines and functions wherever I desired, just as if they were "built-in functions." In P86 the LINK86 program seemed to want all of these programs linked in the command file even if they were never used. If the program is missing it will not create anything more than an annoying error message. I didn't know this, so I cleaned up all of my subroutine references. Upon checking with DRI, I was informed that this problem was corrected in V.1.2 of the linker.

There was one other nasty bug in the area of the linkage editor. If you define any 8-bit quantity, e.g., fixed binary (7) or bit (8) with a static initial value, the linkage editor will not be able to link the program and will report an "OBJECT ERROR (3)." This results from an overall design error in the format of the .OBJ modules. Fortunately, the static initial values can be circumvented by programming. This bug seems to be traceable directly to Intel, and is not really the fault of Digital Research.

Other areas of the programs tested did move over smoothly to P86 from P80. I found an error in the compiler's treatment of compound conditional statements prefixed by a "not" operator. This could be fixed by breaking the statements into two separate statements or by applying logic to remove the "not" term. I spoke to Digital Research about all of these problems, which they are aware of and are trying to fix.

How does the compiler run?

Very well. It is very fast but it is a multipass compiler, which means that it processes the source program more than once. This makes it slower than a program that makes only one pass over the source code. I do not understand how you could use this compiler on a machine like the IBM PC unless you had a hard disk. The compiler has three overlays and a large runtime library. A big program complex can be compiled comfortably on a dual 1.2 MB 8" floppy disk system, but you would really need more than 320K disks to hold the compiler, the linkage editor, your source programs, the object files (.OBJ), and a text editor as well as the test data and runtime library. To make disk space tighter, the compiler builds an intermediate file (.INT) during compilation, which it deletes afterwards. All of my tests were done on a 256K 8085/8088 5 MHz CompuPro system with a 512K M-Drive/H and dual Qume double-sided, double-density 1.2 MB floppy disks. For test purposes, M-Drive/H was made unavailable during compilation. When the M-Drive/H was used, compilation speeds were dramatically increased—by a factor of 60-70%.

What does the object code look like?

I told you in my report on the P80 compiler that the object code was very good. At first glance, the 8086 object code generation seems for some reason to look worse than the 8080. Looks are deceiving. The code *is* very good, but it is compiler code. The P86 compiler is not smarter than any other compiler. It cannot second guess anything in your program, so that everything it generates is quite general. It does make use of the move instructions and, although some of the code sequences seem too long, on the 8086 they are the fastest way of doing certain operations. Take note that although some operations can be performed with one or two powerful and complex instructions, when you add up the execution clock cycles used by those instructions it is often faster to use a few more of the simple instructions. Some things are more esthetically unpleasant than inefficient. Take the statement:

PL/I-86 is recommended as a compiler that can do string manipulation and arithmetic in a good I/O environment.

```
DECLARE FRETIN CHAR (12) VAR;
IF LENGTH (FRETIN)>4 THEN
```

Even though the character strings cannot be greater than 254 bytes long, the generated code will be:

```
MOV   AL,BYTE PTR FRETIN
                  ;GETS THE LENGTH
                  ;OF THE STRING
XOR   AH,AH       ;ZEROS THE HIGH
                  ;ACCUMULATOR
CMP   AX,4        ;DOES A WORD WIDE
                  ;COMPARISON
JG    TRUEBRANCH  ;NOTE THAT THE
                  ;FIRST BYTE OF
JMP   FALSEBRANCH ;CHAR(N)VAR IS
                  ;THE LENGTH
```

This is really not bad, because how many times will you execute it and how many times does it occur in the object program? But there is no need to do word-wide arithmetic just so the compiler can use the signed jump instructions. From the user standpoint it looks bad, but if you have ever written a code generator it is understandable how this gets generated. If you consider the complexities of the PL/I language and how much of it is in this implementation, the generated code is good. At least nobody at Digital Research tried to hide the code by not allowing you to see an assembly listing interspersed with the source program.

Library subroutines

The heart of most compiled programs is the relocatable runtime library. The library seemed to work well. There were some problems with formatting fixed decimal output, though most other routines worked fairly well. In converting character to binary, there were problems with aligning the data for conversion. This error is in P80 also, but since I converted my programs just by recompiling them, I couldn't test this error without writing a special program—which I did. Guess what? The error is still there! I suppose that if they changed it now, all of those nice P80 programs would have to be fixed, too. Some subroutines in the library seemed to be mechanically translated from an 8080 program, but this is just a feeling I got while looking at them with the DDT86 program.

The support programs

Supplied with the P86 compiler is the RASM86 assembler, a version of ASM86 that produces relocatable .OBJ files suitable for collection with LINK86, the companion linkage editor. This assembler has no macro facility, lacks structures, procedure names, and some other features that are certainly desirable in any assembler for the 8086. It does not conform to the Intel 8086 assembler, and is also quite slow. However, it does not require much memory space—a desirable feature on small systems. According to Digital Research, they do not plan to add a macro facility or any other features found in the Intel 8086 assembler to their assemblers.

The linker LINK86 is not a fast program. Considering that everything funnels through LINK86 during program development, it's a bottleneck. Putting the link files on M-Drive/H helps, but not dramatically. The version I got worked exactly as it was supposed to because some amending documentation said that certain features were not implemented. I had version 1.1; version 1.3 (now released) might be faster, and I understand that the unimplemented features are now implemented. Linking an overlay program is so slow that it is possible to go downstairs to the kitchen and make a cup of hot coffee before the linker finishes. An advantage of LINK86 is the ability to have all of the

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PL/I-86

Continued from page 125

link input in a file so that you need only mention the file in the LINK86 control statement. This is really useful in complex program linkage, where there are overlays and more than one library.

There was a problem in the generation of a "small memory model" program where the data segment was not biased by 0100H by the linker to allow for the base page. I do not know if this has been corrected, but if it hasn't, all of the first 256 locations of your data segment will get written over the base page.

LIB-86 is a librarian program that can build libraries from multiple .OBJ files suitable for searching by LINK86. The librarian can also edit libraries and list their contents.

XREF-86 generates a symbolic cross-reference table from the listing and symbol table files of a RASM86 assembly. I tried this, and it works well, though it is very slow.

Overlays

I used the overlay facility in P80 and P86: I found it easy to use and a very good way to save memory space. It is very difficult to use DDT86 on overlays, so debugging of overlay segments is tough. My advice is don't use overlays until programs work without them, then put in the overlays. Loading an overlay from the disk is very fast. If you have something like M-Drive/H or SemiDisk, it is not really noticeable when an overlay gets loaded.

Documentation

Those same little IBM-style binders form the repository for P86 documentation and the support package. All this fits in one binder, and is exactly the same in almost every respect as the P80 documentation. There are a few errors, corrected by a "read.me" file on the distribution disk. When I printed out my "read.me" file, it was four pages long. Oh well, at least you know that there are problems before you start. In the overlays section of the PL/I programming guide you learn 1) that P86 constructs a "small memory model" and 2) that you will not discover whether your program is too big for this model until you try to link it.

I personally do not understand the placement of information in any of the Digital Research manuals. The programming guide is very difficult reading because there is a lot of important information in a small space. Psychologically this makes it very tough going. However, pictures are used to an advantage, and two-color printing with the examples in light brown improves the esthetics. The old manuals were typewriter produced and were as hard on your brain as they were on your eyes.

Technical support

In a word, *yes*—they do give it. I suppose that they recognize my name by now, so it's not fair to evaluate the service that I got, which was superb—including returned calls and reports as to what Tech Support found. So, I went undercover and checked them out that way, too. They do almost the same job with the undercover name (and a different compiler serial number) as they did with me. This is one of Digital Research's strongest selling points: they do stand behind their product. As a user you cannot be unreasonable about what they should do for you. They cannot debug your programs, fix compiler errors overnight, or extend the compiler to do things it was not built for. I guess that a few years on that end of the business makes me more sympathetic to systems software writers.

Summary

Digital Research has invested a lot of effort in their PL/I products. Both the P80 and P86 compilers are useful products. When the P80 compiler was introduced I felt it was a significant software tool. I cannot have a different opinion about the P86 compiler. I have one of the earliest versions of this compiler (I pestered them until I got it) and, considering its age, it works very well. The support tools (especially the LINK86 program) need some hand polishing to speed them up. RASM86 is not a good assembler but, if used to write some support routines to interface with PL/I-86, it works. XREF86 generates a symbol cross-reference list; it is very slow. LIB-86 does create and change libraries. To this extent it works, and I never tested it further. I can unequivocally recommend the purchase of PL/I-86 to anyone desiring a compiler which can do string manipulation as well as arithmetic in an environment which will support good I/O facilities.

The few bugs in the compiler do not make its use difficult but you should try to get the latest version you can.

The PL/I-86 compiler and its tool set are available on 5¼″ SSSD IBM-format disks from your software distributor for about $700. DRI no longer sells software directly to individual customers, and they supply all 8086 software on 5¼″ IBM-format disks.

The previous 8″ format is not available, but Digital Research claims you can get it from distributors. ◼

Andrew L. Bender, M. D., 641 Victoria Terrace, Paramus, NJ 07652

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The CAT 1600 Series lets you take full advantage of your color graphics potential.

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Software Directory

Software packages designed to enhance the capabilities of your computer system

Program name: The cLINE
Requirements: IBM PC or XT
Minimum memory: 256K
Language: C
Description: The cLine is a complete package of interactive software development tools that generates programs in the C language. It contains: cENGLISH; the cENGLISH compiler; the Applications Workbench; language translators. cENGLISH has powerful English-like commands, compiles into portable high-level object code, provides powerful relational-DBMS access capabilities, but remains DBMS-independent, and allows direct escape into object-level programming. cENGLISH requires the presence of a DBMS and can simulate any operation the DBMS cannot perform, so that any operation serviced by more than one DBMS can be unified at the command level. cENGLISH programs can always access data without conversion. The Applications Workbench aids in the design, implementation, debugging, testing and documentation of applications programs. It has a cENGLISH command interpreter, the cEDIT program editor, cSCREEN design tool, and a program code control system, plus on-screen HELP facilities. The language translators convert source programs into cENGLISH code to be compiled into C programs. MS-DOS and CP/M versions are under development.
Price: $995
Available from:

cLINE, Inc.
Portsmouth Parade Mall
Portsmouth, NH 03801
(603) 431-2111

CIRCLE 300 ON READER SERVICE CARD

Program name: Frame Editor
Requirements: IBM PC or XT, UNIX-based DEC VAX, Plexus or Onyx
Miniumum memory: IBM: 256K; others: 128K
Language: C
Description: Designed for use with a digitizing pad or optical mouse, Frame Editor allow nonprogrammers to interactively create free-form graphic designs having squares, circles, rectangles, and other geometric forms in 16 colors selected from a palette of 4,096. Frame Editor is NAPLPS compatible. NAPLPS (North American Presentation-Level Protocol Syntax) is an ASCII-compatible color graphics standard, designed to mix graphics and text in an efficient, compact, hardware-independent format that encodes files within a compressed format for transmission via phone lines.
Price: $500-2,000 (depending upon the type of host computer)
Available from:

Verticom, Inc.
545 Weddell Dr.
Sunnyvale, CA 94089
(408) 747-1222

CIRCLE 301 ON READER SERVICE CARD

Program name: LRPARSER
Requirements: CP/M and on-line disk storage of roughly 400K
Miniumum memory: 57K
Language: PL/1-80
Description: LRPARSER is a true LR(1) parser constructor optimized to produce compact efficient parsing machines. LRPARSER takes as input a context-free grammar in BACKUS-Naur (bnf) form from which any or all unit productions may be eliminated. Output is an easily understood computer subroutine (presently coded in PL/1-80) which drives the parsing tables constructed from the grammar. The programmer should insert code into the "reduce areas" of the output procedure to produce a full application. A symbolic representation of the parsing machine may also be output. LRPARSER comes with a complete manual. A short section shows how to use the software, the next how to apply LR parsers to applications, build grammars, resolve conflicts, recover from user error, and design lexical scanners. A utility program, LRMERGE, is also included so that parsers generated by LRPARSER for revised grammars may be merged into an existing application.
When released: 1983
Price: $395
Available from:

The Software Tree,
1455A Alewa Dr.
Honolulu, HI 96817
(808) 595-7129

CIRCLE 302 ON READER SERVICE CARD

Program name: PICDMS
Requirements: Apple IIe running CP/M-80 and a PL/I compiler
Miniumum memory: 56K
Language: PL/I
Description: PICDMS is a set of grammatical rules allowing very simple commands to specify simple image-processing or modeling operations; slightly more complicated commands can describe operations not found in any existing computer system. PICDMS can operate on any digitized photograph, map, drawing, or two-dimensional variables, such as elevation measurements, electric fields or population models. Operations include such functions as detection of objects or edges of objects in pictures, contrast sharpening, pattern recognition and classification, histo-

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SOFTWARE

Continued from page 128

grams and statistical analysis, determination of minimum and maximum values, interpolation of scattered measurements to form a smooth surface, calculation of distances, areas, and volumes, and modeling processes that change over space and time. PICDMS builds "stacks" of pictures. These stacks can represent three-dimensional objects, portray changes over space and time, plot multidimensional variables, or model complicated processes based on the interaction of several factors over the same area, so that programs may be customized for specific tasks.

Price: $65,000

Included with price: Software license, user's manual and two-hour consulting.

Available from:

M.I.B. Chock
1048 24th St.
Santa Monica, CA 90403
(213) 828-4788

CIRCLE 303 ON READER SERVICE CARD

Program name: Report Manager

Requirements: IBM PC, two disk drives or hard disk

Miniumum memory: 128K

Language: assembler

Description: Report Manager allows the user to access a computer's full complement of characters (255 for the IBM PC) for chart graphics, including bar charts, histograms and scatter or plot charts; as alternatives to score-line markers for subtotals, totals, key entries or entire sections; as demarcation separators, as might be used in designing questionnaires, templates and other forms not usually associated with spreadsheets. Report Manager also offers the option of turning off the spreadsheet grid to provide different looks for the finished report.

Once a graphic format has been determined, it can be automatically invoked using simple commands in EXEC, Report Manager's front-end programming language. This provides an easy way to establish a standard look for report graphics without requiring the user to repeat the design exercise. With EXEC, the user need only answer specified prompts: Report Manager can place these answers into their proper context and generate the finished spreadsheet, graph or report. Report Manager is organized into 255 rows by 255 columns by 255 pages, any of which can be addressed at any time. This means that each Report Manager spreadsheet can reach more than 16 million data cells (limited by disk storage space, not CPU memory). Report Manager can also automatically adjust its operations to fit available system RAM. Report Manager includes Datamension's Dimension Aid, a system of user assistance that includes an on-line help function, a training diskette and a detailed, easy-to-follow tutorial.

cENGLISH programs can always access data without conversion.

Price: $495

Available from:

Datamension Corp.
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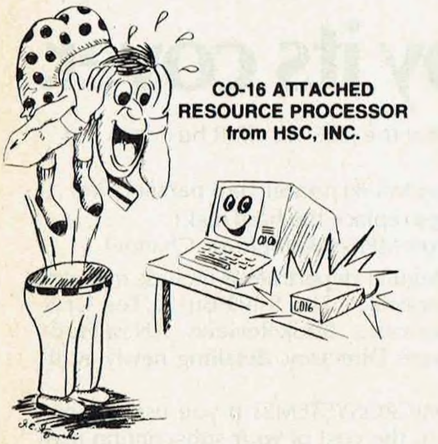

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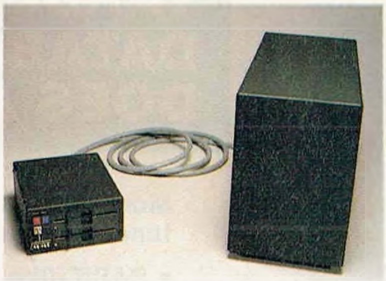

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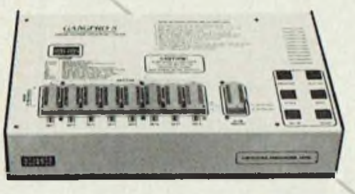

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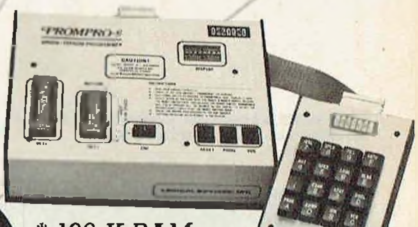

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- ☐ 1. Manufacturing of computer equipment, computers, DP hardware, peripherals
- ☐ 2. Manufacturing other
- ☐ 3. Agriculture, mining, construction
- ☐ 4. Transportation
- ☐ 5. Communications
- ☐ 6. Utilities
- ☐ 7. Computer related retailer
- ☐ 8. Non-computer related retailer or wholesaler
- ☐ 9. Finance, banking, insurance, real estate
- ☐ 10. Health, medical service
- ☐ 11. Legal
- ☐ 12. Education
- ☐ 13. Data processing, computer service
- ☐ 14. Other business services
- ☐ 15. Government
- ☐ 16. Consultant
- ☐ 17. Other (please specify) ____________

4. Your title: (Check one appropriate box)

- ☐ 1. Pres / Owner / Dir / Chmn / Partner
- ☐ 2. Vice-Pres / Gen Mgr
- ☐ 3. Comptroller / Treasurer
- ☐ 4. Vice-Pres Finance
- ☐ 5. Chief Accountant
- ☐ 6. Vice-Pres Operations
- ☐ 7. Dir / Mgr Purchasing
- ☐ 8. Dir / Mgr Office Systems
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- ☐ 16. Dir / Mgr Information Ctr
- ☐ 17. Business Microcomputer Specialist
- ☐ 18. Systems Analyst
- ☐ 19. Data Base Administrator
- ☐ 20. Vice-Pres / Dir R&D
- ☐ 21. Vice-Pres / Dir Engineering
- ☐ 22. Dir / Mgr Plant or Prod
- ☐ 23. Chief Engineer
- ☐ 24. Systems Engineer
- ☐ 25. Design / Production / Research Engineer
- ☐ 26. Consultant
- ☐ 27. Educator
- ☐ 28. Other (please be specific) ____________

5. Do you have any *MAINFRAME* computers or *MINICOMPUTERS* on site at this location?

- ☐ Yes (If yes, please report accurately below for the two largest.)
- ☐ No

Manufacturer	Model	Quantity

IBM or Compatible Personal (Micro) Computer Information for this location:
(Please report accurately for each model indicated)

Manufacturer's Name, Model	6. Currently Owned (Quantity)	7. Plan To Purchase Within: 0-12 Months (Quantity)	13-24 Months (Quantity)	25-36 Months (Quantity)
IBM PC				
IBM PC XT				
IBM XT/370				
IBM PC/3270				
IBM PCjr				
IBM Compatibles (Compaq, Eagle, etc.)				
Other (Not IBM or Compatibles)				

7a. In which of the following ways are you yourself involved with the *Personal (Micro) Computers* at your location?

- ☐ A. Use them
- ☐ B. Recommend them
- ☐ C. Establish specifications
- ☐ D. Approve purchase
- ☐ E. Acquire them
- ☐ F. Other Involvement (specify) ____________
- ☐ G. No involvement

8. The *Personal (Micro) Computers* purchased for this location would be:

- ☐ 1. For internal use
- ☐ 2. For resale
- ☐ 3. Other (please specify) ____________

Full company name and company address must appear in spaces below for application to be processed.

OR AFFIX YOUR BUSINESS CARD

Name ____________
Title ____________
Company Name ____________
Division ____________ Telephone Number ____________
Company Street Address ____________
Company City ____________ State ____ Zip ____

8a. How are Personal (Micro) Computers normally obtained for this location?

- ☐ A. Direct from manufacturer
- ☐ B. Manufacturers representative
- ☐ C. Distributor
- ☐ D. Retail computer store
- ☐ E. System house
- ☐ F. In-house (company) store
- ☐ Z. Other (please specify) ____________

9. Please indicate below the communications capability for which these *Personal (Micro) Computers* are used.

- ☐ A. Communicate with remote timesharing or database.
- ☐ B. Communicate with internal mainframe or minicomputer.
- ☐ C. Used in local area network.
- ☐ D. Down load data from mainframe or remote service.
- ☐ E. None of the above.

9a. Please indicate below the applications for which these *Personal (Micro) Computers* are used.

- ☐ 1. Accounting
  - ☐ A. Accounts Payable
  - ☐ B. Accounts Receivable
  - ☐ C. Billing & Collection
  - ☐ D. General Ledger
  - ☐ E. Inventory
  - ☐ F. Order Entry & Invoicing
  - ☐ G. Time Billing
- ☐ 2. Communications
- ☐ 3. Data Base Management
- ☐ 4. Data Input / Analysis
- ☐ 5. Education
- ☐ 6. Electronic Mail
- ☐ 7. Entertainment (Games)
- ☐ 8. Financial Planning
- ☐ 9. Graphics Design
- ☐ 10. Personal Time Management
- ☐ 11. Portfolio Management
- ☐ 12. Programming
- ☐ 13. Project Management
- ☐ 14. Process Control
- ☐ 15. Scientific or Engineering Applications
- ☐ 16. Statistical Analysis
- ☐ 17. Tax Calculation or Planning
- ☐ 18. Word Processing
- ☐ 19. Other ____________

10. Do you help acquire, recommend, specify or approve any of the products or services below?

- ☐ Yes (If yes, please check all that apply)
- ☐ No.

Computers

- ☐ 1. Mainframe
- ☐ 2. Minicomputer
- ☐ 3. Personal (Micro)

Peripheral Equipment

- ☐ 7. Letter Quality Printer
- ☐ 8. Graphics Printer
- ☐ 9. High Speed Printer
- ☐ 10. Color Monitor
- ☐ 11. Monochrome Displays
- ☐ 12. Modems
- ☐ 13. Hard Disk
- ☐ 14. Tape Backup System
- ☐ 15. CPU Compatibility Card
- ☐ 16. Memory Board
- ☐ 17. Communications Port
- ☐ 18. Plotters / Charting Devices
- ☐ 19. Local Area Networks

Software Packages

- ☐ 21. Communications
- ☐ 22. Accounting
- ☐ 23. Order Entry / Inventory
- ☐ 24. Payroll
- ☐ 25. Time Billing
- ☐ 26. Financial Planners / Spreadsheet
- ☐ 27. Project Managers
- ☐ 28. Word Processors
- ☐ 29. Compilers
- ☐ 30. Database Managers
- ☐ 31. Program Developers / Generator Tools
- ☐ 32. Business Graphics

Outside Services

- ☐ 34. Maintenance
- ☐ 35. Education / Training
- ☐ 36. Software / Systems Design
- ☐ 37. Remote Computing
- ☐ 38. Database Services
- ☐ 39. Other

Expendables

- ☐ 41. Diskettes
- ☐ 42. Stock Paper
- ☐ 43. Forms & Other Consumables

11. Are there any other individuals at this location that would qualify for a complimentary subscription to PC WEEK?

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New Products

What's new: a quick roundup of recent innovations and improvements

CIE color graphics card

The CIG-267 is a color graphics plug-in card for its DEC-compatible CIT-161 color terminal that combines DEC alphanumeric software commands and the Tektronix 4027A color graphics command structure. The CIG-267's dual DEC/TEK personality allows CAD, engineering and scientific designers to simultaneously use generic DEC alpha commands in color, in addition to the 4027A terminal's regular color graphics capabilities. The CIT-161 color terminal, hosting the CIG-267 card, provides designers with a 572 x 480 dot resolution and a 75 MHz refresh rate for flicker-free displays. ANSI x3.64 compatible, the terminal has 64 programmable color combinations of its eight primary colors. The card is fully backed by CIE Terminals with warranty and complete service/support organization. With the CIG-267 graphics card list priced at $1,195 and the DEC-compatible CIT-161 terminal at $2,595, the total list price of the DEC/TEK terminal is $3,790. In addition to the CIG-267 card, CIE Terminals offers the CIG-261 color graphics card that extends the CIT-161's performance to include graphics capabilities of the Tektronix 4014 monochrome terminal, though displayed in color. While the command structures of the 4014 monochrome and 4027A color terminals differ, the CIG-267 integrates both terminals as well as graphics/plotting commands. CIE Terminals also offers the CIG-201 monochrome plug-in card for its DEC-compatible CIT-101 monochrome terminal that makes it compatible with Tektronix 4010/4014 models, yet still allows the CIT-101 to retain its DEC-emulating capabilities. **CIE Terminals,** *2505 McCabe Way, Irvine, CA 92714-6297; (714) 660-1421*

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Spool-Z-Q Blue 256-K character buffer

Spool-Z-Q Blue is a 256K true-hardware printer buffer that can send to either parallel (Centronics standard, such as the standare IBM/Epson) or serial (RS-232) printers. To the software, Spool-Z-Q- Blue looks just like the standard IBM Parallel Printer Adapter: all protocols, handshaking, storage and retrieval of characters to be printed, etc. are handled by its on-card Z80A microprocessor. Spool-Z-Q Blue has standard "D" connectors on its card, so no jumper cables are needed to access remote devices. During parallel operation, the 25-pin "D" connector is a pin-for-pin equivalent of the standard IBM Parallel Printer Adapter and uses the standard IBM parallel cable; during serial operation, the 25-pin "D" connector is pin-for-pin compatible with IBM Asynchronous Communications Adapter-RS-232 signals. There is also a 9-pin "D" connector on the back panel. By using the optional switch panel that plugs into it, the following extra functions become available: Pause Printing—stops sending characters to the printer; Self-Test—tests the internal functioning of the buffer and prints the results; Clear—discards the buffer contents; Reset—actual hardware reset of the buffer's microprocessor (does not affect the host processor); Pause-On-Formfeed—stops printing when an ASCII formfeed character is detected in the output to the printer: the buffer will not send characters to the printer until either the "Next Page" button on the optional switch panel is pressed, or the "Normal Print" mode is selected. Normal Print—always enabled when the optional switch panel is not installed.

Spool-Z-Q Blue is available in both parallel-only and serial/parallel combined versions. Each version is available in 32K-, 64K-, 128K-, 192K-, or 256K-character sizes. All sizes are fully socketed for 256K characters and may be upgraded to any intermediate size up to 256K by simply plugging in industry-standard 4164-type 64K RAM chips.

The prices are: Parallel only: 32K: $299; 64K: $329; 128K: $389; 192K: $499; 256K: $509; Serial/Parallel: 32K: $349; 64K: $409; 128K: $469; 192K: $509; 256K: 569.

JVB Electronics, *1601 Fulton Ave., Sacramento, CA 95825; (916) 483-0709.*

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Reset switch for Commodore 64

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NEW PRODUCTS

Continued from page 136

windows have individual color tables, and are central to device-independent operation. They also allow the simultaneous emulation of the DEC VT-100 and Tektronics 4010 terminals. GRAPHOS has its own MC68000 microprocessor to run subroutines in a 130+-command set supplied in firmware. This keeps graphics calculations in the terminal instead of in the host, so that GRAPHOS adds little burden to a multiuser environment. The firmware gives the programmer added facility through routines, such as the Window-Viewport transformation that allows the user to enter floating-point numbers directly, rather than prescaling objects in terminal coordinates. Through segment retention and the use of transformation matrices, an object may be moved, scaled, rotated or placed over or behind other objects. Both GRAPHOS II and III communicate through an RS-232 connector with practically any host computer, and attach to a variety of monitors. The new EEPROM permits saving terminal configurations; an extended setup mode allows fingertip selection of such I/O devices as an ink jet printer, a mouse, a tablet or a trackball. There is a wealth of high-level GKS primitives for use in independent work spaces (GRAPHOS pages) for multiple tasks. Both terminals differ in memory, speed and number of colors: GRAPHOS II runs at 6.25 MHz, has 16 colors displayable on a TTL monitor and is priced at $3,995 (without monitor); GRAPHOS III is an enhanced version capable of generating 32,768 colors on an analog RGB monitor, with a clock speed of 12.5 MHz and more memory (256K vs. 128K graphics RAM; 224K vs. 128K local storage RAM). It is priced at $5,495 (without monitor). Complete packages with 13" and 19" monitors are also available.

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- PROM 200-3 16, 20- and 24-pin industry standard bipolar PROMS.
- PROM 200-4 20- and 25-pin industry-standard Programmable Array Logic (PAL).

The PROM-200 is also available in an IBM PC-compatible version that sells for $350 and may be ordered from: **Advanced Microcomputer Systems,** *6802 NW 20th Ave., Fort Lauderdale, FL. 33309; (305) 975-9515*

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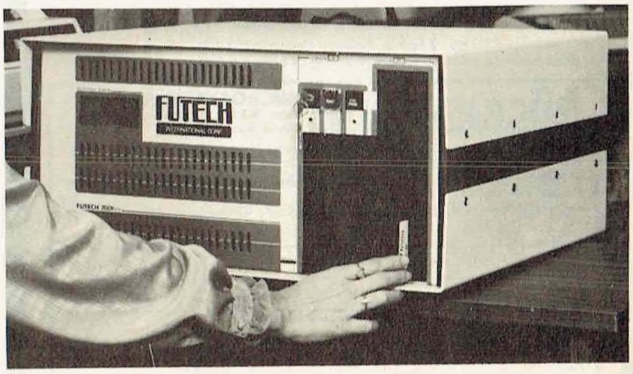

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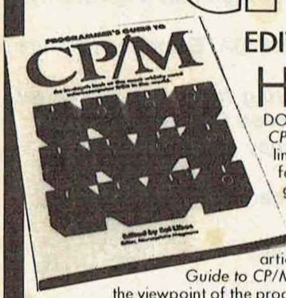
PROGRAMMER'S GUIDE TO CP/M



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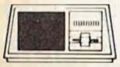

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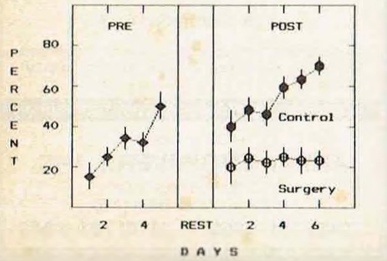

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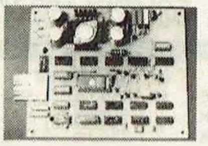

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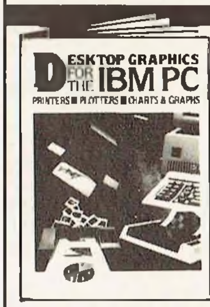
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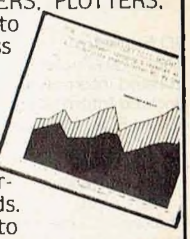

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6. What is the manufacturer and model?__________

7. What is the operating system?
1. ☐ CP/M (or CP/M derived).
2. ☐ UNIX or (UNIX derived).
3. ☐ MS-DOS (or derived).
4. ☐ Other.

8. What best describes the work you do with this microcomputer?
5. ☐ Business functions
6. ☐ Software/Hardware development
7. ☐ Science/Engineering/R&D applications

9. Do you yourself get involved in the purchasing of microcomputers and related products for your company or organization?
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o. ☐ Yes a. ☐ No

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	1 Own	2 Plan to Buy
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Heath/Zenith	E	P
IBM	F	Q
Radio Shack/Tandy TRS 80	G	R
Texas Instruments	H	S
Timex Sinclair	I	T
Other (specify)	J	U
None	K	V

3 For what, if any, business application(s) do you use the microcomputer you currently own?____________________

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5. Is this an S-100 Microcomputer?
y. ☐ Yes z. ☐ No

6. What is the manufacturer and model?__________

7. What is the operating system?
1. ☐ CP/M (or CP/M derived).
2. ☐ UNIX or (UNIX derived).
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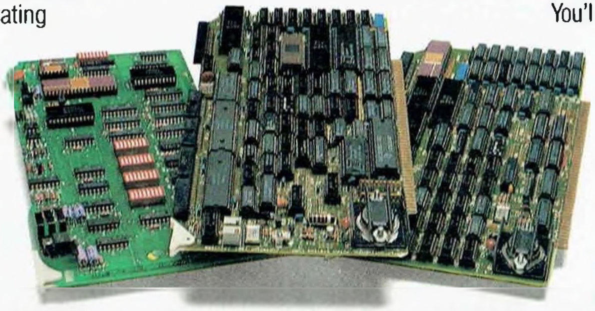

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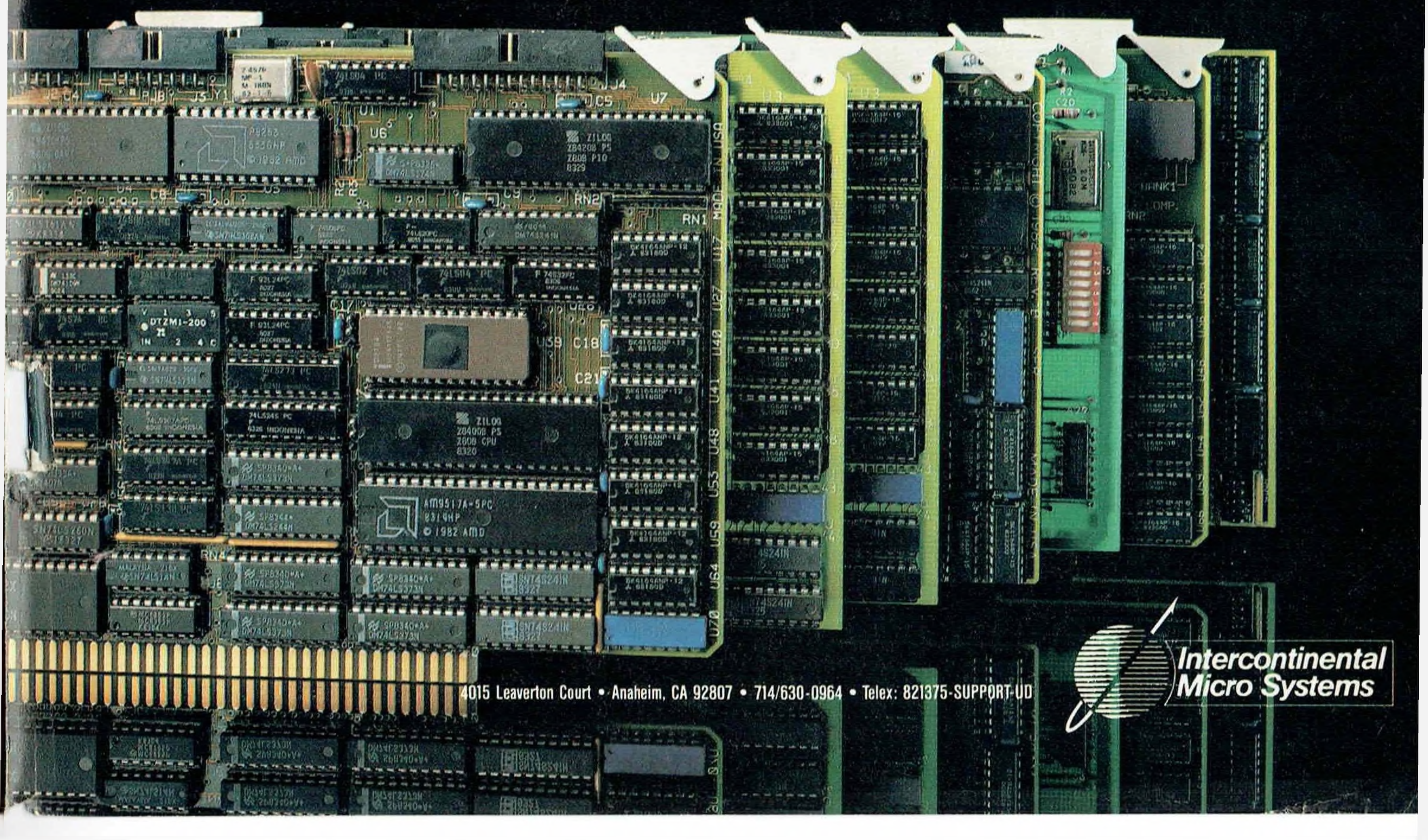

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